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THE PRINCIPLES OF
HUMAN NUTRITION

By ✓

HARVEY W. WILEY, M.D.

DIRECTOR, BUREAU OF FOODS, SANITATION AND HEALTH,
GOOD HOUSEKEEPING MAGAZINE,

AND

AUTHOR OF "1001 TESTS OF FOODS, BEVERAGES AND
TOILET ACCESSORIES"



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FOREWORD

IN the following lessons an effort has been made to present the principles of man feeding in plain and simple language for the use of the non-scientific reader. The views of the author respecting the proper foods for infants and children are not shared by all dietitians, but are coming more into vogue. Simplicity and variety are the keynotes of this treatise—with a strong tendency to keep our foods as near to Nature as possible.

The title shows that I do not believe in a “one-diet,” nor on the other hand do I favor indiscriminate variety. Simplicity is possible with few foods, but not with over many.

This book is for the mother, especially the mother who believes health is the greatest asset of infancy and childhood. At the same time the father also will be interested in, and I hope informed by, reading it. Better babies and healthier children will make more efficient men and women. The teacher in public and private

schools will, I hope, find valuable aid in these pages in protecting the health of the children and in securing for them a better and a cheaper diet. "To be a good animal is the first duty of the citizen."

H. W. WILEY.

January, 1916.

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LESSON I

INTRODUCTION

THE greatest industry in any community is eating. This is not an industry confined to a particular class of people; it embraces every individual of the community. There are no child-labor laws regulating this industry. Infants engage in it immediately after birth. Old people continue the industry to the brink of the grave. The magnitude of the industry is not appreciated as it should be. If we count the time spent in eating alone, it is of considerable extent. If one should live sixty years, which is considerably above the average, and eat as he should eat according to the principles of Fletcher and his school, he would spend almost three hours a day at the table. This is one-eighth of his life, and in sixty years would amount to seven years and a half. This is probably an exaggerated time compared with actual work at the table, but including the time of preparing for the dinner in a proper way and the time consumed in a proper way in social

intercourse at the table it may be regarded as approximately correct.

TIME SPENT IN EATING

The time spent at the table, however, is not by any means all the time spent in this great industry. We must have something to eat and have it properly prepared. There is no way of getting exact data on this point, but it is probable that after reaching the age of service the average man or woman spends four hours a day either in getting something to eat or in preparing it to be eaten. In forty-four years of adult life one-sixth of the time may properly be ascribed to these efforts. In round numbers, seven years and a half of the allotted time of adult life in sixty years of living, namely, forty-four years, is devoted to getting food and preparing it to be eaten.

But this is not all of the time which we devote to this industry. Sleep is intimately connected with nutrition. It is during sleep that the numberless carpenters and masons that build the body and repair its waste are chiefly busy. During sleep new particles are built into the body and the old particles are taken out, thus completing the work which was commenced at the table. We

should sleep eight hours a day. One-third of our time is spent at complete rest or asleep. In sixty years this would amount to twenty years. Add that to the fifteen years which we spend sitting at the table and getting something to eat and preparing it to be eaten, and we have a total of thirty-five years of the sixty years we live devoted to this one great industry.

It is consequently a matter which should engage our closest attention. We should be trained, if possible, to engage in this industry with the maximum of skill and benefit. Do we do this? No. Here is one great industry in which there are few skilled laborers. Everyone is a common day laborer with no idea of the nature of the business in which he is engaged and with no special skill to perform the duties of that business with effectiveness and benefit. Not being skilled laborers, nor experts, we may expect to draw the minimum salary. That minimum salary is paid to us in diminished years of life and in diminished efficiency while we live.

It is true that there are now quite a large number of persons who have made the subject of dietetics a study. The number of persons who are engaging in this study is daily increasing.

Instead of being a mere theory, the tenets of nutrition are now assuming scientific form and accuracy. One-third of a century ago there was probably not a medical college in the country that taught any scientific theory of diet. Today one of the armaments of the physician most prized is to know something of the philosophy of foods. All over the country there are established schools of domestic science which, among other things, teach the principles of human nutrition. Even in the public schools our children are beginning to be taught something of that which is most essential to their welfare, namely, how to live. We are beginning to realize that the feeding of man is of more consequence than the feeding of pigs or steers. Yet there are a hundred people in this country today who know how to feed pigs and steers where there is one who knows how to feed children or grown people.

RELATION OF DIET TO HEALTH

The relations of diet to health are becoming fully appreciated. Already text-books have been written on the value of diet in preventing disease and its usefulness in helping to eradicate it. There is growing up in the country a new science

which I have called bromatotherapy,¹ that is, the remedy of disease through proper diet. There is another school of medicine which might be called bromatoprophylaxis—the prevention of disease through a proper diet. The time seems to be near at hand when intending parents will have more difficulty in securing a license to get married than they have had in the past. In some states already they are expected to show that they have no chronic disease of a character to affect unfavorably the offspring which they may have. If either one of the contracting parties is suffering from syphilis, tuberculosis, cancer, or other serious illness which may unfavorably affect the character of the offspring, he may be refused a license to enter into matrimony. It would be well if we could have a kind of a civil service in matrimony, which would consist not only of a physical examination of fitness, but also of an examination which would disclose whether or not the candidate for matrimony is competent to feed his offspring in a proper way. The gross ignorance respecting the fundamental principles of nutrition which exists among educated persons is phenomenal. Appar-

¹ Presidential address, American Therapeutic Society, Boston, May, 1911.

ently the time has come for a wider propaganda, which will extend into the schools and into the homes of the people.

One reason for the ignorance regarding nutrition as affecting human beings has been in the character of the publications relating thereto. These publications, the results of experimental evidence, have been couched in language which does not appeal to the ordinary intelligent citizen who has had no technical training in matters of this kind. The names of Rubner, Atwater, Benedict, Osborne, Lusk, Chittenden, and many others, while well known among scientific circles, awake no response in the minds of the people. It is evident that the fundamental principles which underlie the science of nutrition should be so presented to the intelligent and educated people of the country as to be readily comprehensible and, if possible, attractive. To this end I undertook to write a series of articles on Nutrition for *Good Housekeeping Magazine*. At the completion of this series the editors of the magazine suggested that it would be wise to collect these articles into book form, expand them somewhat, and thus secure perhaps a wider vogue for them than otherwise could be obtained. In this small work I have

attempted to comply with that request, using the articles which were published in *Good Housekeeping* in 1914 as a text. I have elaborated them in the form in which they are now presented to the public.

TRADITIONAL FALLACIES

Many of the writers on food subjects today, and the number of such writers is rapidly increasing, are spreading abroad mistaken and harmful statements about foods. They do this with the best intentions and as a natural result of faulty training. Some supposed authority makes a statement which is not based on scientific fact, and this statement is repeated in good faith by the popular writer, and, of course, accepted as gospel by the reader. While the statements in the following lessons may not be devoid of error, an earnest effort will be made to base them on well-established scientific data. Where reputable authorities differ in the ascertainment or interpretation of data, I shall follow those whose opinions lead to the greater economy and safety. In judging between economy and health, I shall always favor the latter. The health and happiness of the future depend largely on the education of the people respecting scientific nutrition.

THE SCHOOL AS A TRAINING CENTER

The question may be pertinently asked, How is this education to be secured? First of all, there must be a sufficient number of teachers properly instructed to impart the education, and, second, some facilities must be secured for the teaching. Fortunately there is now a large number of schools of domestic science and economy established either in connection with the official schools of agriculture or with college or university endowments. There is also a number of privately conducted schools, diet kitchens, and similar organizations giving training of this kind. We may look forward confidently, then, to a near future when there will not be a dearth of trained teachers.

To me the most hopeful opportunity to extend the knowledge of human nutrition among the people is afforded by the public school. Many public-school principals and teachers will throw up their hands in protest against any suggestion which looks to the addition of any new study to the school curriculum. I say to them, "Come, let us reason together." I have no desire to place any additional burdens upon our children at school. Rather would I lessen them. And hence,

in suggesting that the principles of practical nutrition be taught to the children in schools, it is only fair that some indication should be made of what is to be left out. In view of the present change in the boundaries of nations, I venture to suggest, in the first place, that the study of geography, aside from local geographical knowledge, is not a necessity in the education of the child. When he grows up and has practical experience and travels he will easily learn all of the geography that the average citizen is required to know. The space made vacant by eliminating geography from the schools, and the time saved, would give a fair opportunity for beginning work.

THE BURDEN OF WEIGHTS AND MEASURES

Another time-consuming study in our schools which might well be eliminated is that of our present system of weights and measures. A system of weights and measures which is wholly arbitrary, or nearly so, and in which there is no correlation between one kind of measure and another, is entirely out of place in the development of modern science. Our fathers who established this nation were wise, in so far as they went, in instituting a scientific valuation for our money.

It is so simple that any intelligent child of six or seven years of age can learn to count money in a few minutes. It is only a ten-ten-ten problem. There is no such coin as a "mill," and the term "mill" should be dropped from our system of counting money. It only serves to confuse. We then begin with the simplest and smallest measure, the cent. It is not wise to have both a thousandth division and a hundredth division in the same system of enumeration, and when the mill (thousandth) is gone this will be the case. We then have only two necessary terms in the counting of money, the cent and the dollar. For convenience we may continue the dime, though it is rarely used in polite society; also the quarter and the half, though the terms "twenty-five cents" and "fifty cents" are used immeasurably greater times than the quarter or the half. Then we need only teach the child the cent and the dollar.

If we had the same simplicity in the rest of our weights and measures, the whole problem would be solved. The opportunity to eliminate this difficulty is constantly presented to the people of this country. Already the decimal system of weights and measures, in vogue throughout almost the civilized world, with the exception of England and

the United States, is permissible in this country by act of Congress. We need to go just one step further and make it obligatory. We hardly need change the denominations with which we are familiar, but only need give them a slightly different value, to which we would in a few months become entirely accustomed. A few illustrations will emphasize my meaning. The quart would hardly have to be changed at all to represent the liter. The pound would require only a very slight change to become half a kilogram. The yard would have to be lengthened by about 10 per cent. to become the meter. We could keep the quart, the pound, and the yard, and let the other measures go. The abolition of the burden of learning the present unscientific, time-consuming, trouble-brewing chaos of our ordinary weights and measures would give all the time necessary, and more, to teach our children the fundamental principles of nutrition.

Those who have not tried to instruct children in this matter will be surprised to know how eager they are to learn living things and things which relate to life, and how retentive they are of the principles which they acquire. There is no reason why a child of three should not understand the

fundamentals of nutrition. In my own experience I have found that it is an easy task not only to make the child understand, but, above all, to have a real interest in the matter and to apply it to his own method of life with enthusiasm as well as success and benefit.

Further than this, the abolition of our present system of weights and measures, with its three or four different kinds of gallons, its two kinds of pounds, its innumerable designations of measures of volume, measures of weight, and measures of length, which have no relation to each other at all and are purely arbitrary, would restrict the opportunity which is now so largely practiced of short-weighting what we buy and long-weighting what we sell. A simple decimal system of weights and measures such as is now used throughout the whole world, with the exceptions noted, would do much to make dishonesty more difficult and honesty more popular.

Thus, without placing any additional burden upon the child in school, and, in fact, greatly lightening the burdens which he now struggles to bear, we could teach all the fundamental principles of nutrition in a manner whereby their practical application would at once become gen-

eral. The parents at home will not be long to adopt a system of scientific nutrition which their children learn at school and tell them about at the table.

LESSON II

PIGS *VS.* INFANTS—DEFINITIONS

HUNDREDS of schools in this country are engaged in teaching teachers how to teach.

They are doing fine work. Their number and efficiency should be increased. Nearly fifty colleges in this country are teaching young men how to feed pigs physiologically and economically. Rations are analyzed and compounded for particular purposes and classes of animals. Stock to be kept over the winter for pasture the next summer are fed very different food and in very different quantities from animals fed for meat or for the production of milk. There should be more and better teaching of this kind. There are also many schools of so-called domestic science in which the art of housekeeping in all its ramifications is taught. We should have more schools of this class, and they should teach the fundamental principles of nutrition which every housekeeper should know. This magazine proposes to open a new school of domestic science, with twelve

hundred thousand students at the beginning. This, beyond doubt, is the most far-reaching university extension course that has yet been attempted.

THE GREAT ECONOMIC PROBLEM

The great economic problem of the near future is the feeding of man. But that is just what the great technical schools before mentioned have not taught. The women of the country will play the leading rôle in solving this great political-economical problem. In many states they already vote. In many more they soon will. Whether voting or not, this world-wide problem of nutrition appeals most strongly to them. They can neither ignore nor evade it. Therefore they must study it. Food, clothing, and shelter are the faith, hope, and charity of the new gospel, which, when accepted, will lead the nation into the new freedom. Therefore every woman should know the essential principles of nutrition.

The increase in the cost of foods is one of the most threatening dangers to the stability and progress of the community. One of the chief causes of this increase lies in the widespread ignorance of the composition and function of foods.

I think I may safely say that at least twenty-five per cent. of the food cost to-day is exacted because of the ignorance of the housewife on this subject. All the students in the *Good Housekeeping* school may count on being able, after graduation, to save twenty-five per cent. of the present and future cost of foods. Is not that worth doing?

Furthermore, a large part of the ill health of the community, and perhaps fifty per cent. of that of the children, is caused by ignorance in regard to nutrition.

INFANT MORTALITY

The mortality among the infants of this country under the age of one year, according to the data collected by the Bureau of Vital Statistics of the Census, amounts to one hundred and twenty-seven per thousand. This is a terrible toll to exact of humanity. Twelve and seven-tenths per cent. of the children born every day in the United States, and there are several thousand born, live less than a year. If we analyze the causes of this great mortality, we shall find that defective nutrition is the most important one. The infants who die may die directly from the

effect of poor food, insufficient food, too much food, or food administered at the wrong time. If they do not die directly from these causes, their vitality is so diminished by improper diet that they are easy victims of measles, whooping-cough, scarlet-fever, diphtheria, and other diseases which are prevalent among children.

One of the greatest causes of infantile mortality is the summer diarrhea, very properly called by the mothers of years ago "summer complaint." This intestinal disease, while due to an organism, is directly promoted by improper food. In fact, the exciting cause of the diarrhea is injected in the food. Especially is this true if the infant is not naturally nourished. The infant at its mother's breast has a life insurance, not from New York, but from Providence. The chance for life of the infant at the breast of a healthy mother is very many times greater than if the infant is fed any kind of artificial food. In many cases, however, it is necessary that the infants have artificial food. There is only one substitute for the mother's milk that ought to be given. That is the modified milk, fresh, clean, and properly handled, of a cow that is healthy. When modified under the prescription of a physician to resemble the

milk of the mother, the infant's life may often be saved. Alas, too often does the infant have dirty milk, old milk, milk from infected animals. It is a miracle if an infant thus nourished lives through the year. Almost the first lesson in nutrition is that infants should have the milk of a healthy mother, and when that is impossible, the best substitute that can be secured.

In this country the milk of the cow is the only substitute available. In other countries the milk of the goat is often to be had. In Europe I have seen the goats driven up in front of the house and the warm, fresh milk used for the nutrition of the children. This is not likely to occur in this country. While the milk of the cow is not ideal for the human infant, it can be so modified by diminishing its content of protein and increasing its content of milk-sugar as to be an acceptable substitute for mother's milk, if it can be had under sanitary conditions.

FUNDAMENTAL DEFINITIONS

Food, in the physiological sense, is that which, when properly introduced into the body, builds tissue, restores waste, and furnishes heat. These are the three great functions of foods, all of which

must be performed. This does not by any means imply, however, that the secondary function of food as a means of social enjoyment should be neglected. In fact, an attractive table and congenial companions serve to render more effective the primary purposes of food.

Classes of Foods: Foods comprise four classes:

a. Nitrogenous foods, or proteins, which nourish the muscles, brain, nerves, and tendons, and furnish some heat.

b. Starchy foods and sugars, commonly designated as carbohydrates, which nourish the fatty tissues, and furnish heat.

c. Fat foods (oils), which take little part in tissue-building, but are fundamentally heat-producers.

d. Mineral foods (common salt, lime, phosphorus, iron, etc.), which nourish particularly the teeth and bones, and furnish the acids and salts necessary to digestion and the translation of fluids in the body.

Calorie is a term used to indicate the quantity of heat afforded by a food product during the process of its journey through the body, or as determined by burning the food in a calorimeter and measuring the quantity of heat produced.

The unit of measure is one gram of water (15 grains); the unit of temperature is one degree centigrade (1.8° F.), and the initial temperature of measurement is that of the living-room, about 70° F. A calorie, therefore, measures the quantity of heat which will raise the temperature of one gram of water one degree centigrade. When spelled with a large C, except at the beginning of a sentence, Calorie designates the quantity of heat required to raise one kilogram (2.2 pounds) of water one degree centigrade. One Calorie is therefore equal to one thousand calories.

When a food is completely burned in the body, the same number of calories is produced as if it were burned in a calorimeter. Thus fat which is used in the body produces the same number of calories as fat that is burned in a calorimeter. The same is practically true of sugar or starch. On the other hand, when a nitrogenous food, protein, is burned in the body, the combustion is not complete; in other words, the residues of the digestion of protein matter are still capable of further oxidation. Urea is an example of such an incompletely burned product. The utilized calories of protein are therefore fewer in number

than the calories of protein burned in a calorimeter.

It is highly important to have a clear understanding of what the fuel value of food means. So much has been said respecting the judgment of a food by this heat-forming property that the reader not posted in the details of nutrition is likely to be entirely misled. An understanding of how the heat value of food is measured in the body and out of it will help clear away the maze which so generally surrounds the discussion of this subject.

The heat value of food when burned in the ordinary way is measured by an instrument called the calorimeter. The calorimeter must not be confounded with the thermometer, though one is a Latin and the other a Greek name of like meaning. The thermometer measures the *degree* of heat, not its *quantity*; the calorimeter the *quantity* of heat, not its *degree*. If you were to stick a thermometer into an iceberg five hundred miles long, three hundred miles wide, and a mile thick, it would register exactly the same degree that would be obtained if you were to put it into a mass of ice just sufficient to cover the bulb. A thermometer in a tank of boiling water that contained a

million gallons would register exactly the same degree of heat as if it were placed in a cup of boiling water containing half a pint. On the other hand, the calorimeter measures the amount of heat.

THE CALORIMETER

If you measure the heat produced in the human body, there must be a room of a uniform temperature (calorimeter) in which the human body is placed. To measure properly the quantity of heat in natural digestion (metabolism) the temperature of the calorimeter should be near that of the ordinary working-room. A temperature of 20°C . (68°F .) is most suitable for that determination. It would be difficult to give a description of a calorimeter of this kind in sufficient detail to be of any value. It is a very complicated apparatus, must be large enough to hold a man of normal size comfortably, and so built as to completely eliminate any influence of external heat or cold.

The total quantity of the heat engendered is measured by a given weight of water, which has a higher capacity for heat than any other substance. This water circulates around the room at a given

temperature and with a measured volume. At the end of the test the water has a higher temperature and a slightly increased volume. The degree of the increase in heat, measured by the thermometer, multiplied by the weight of water, will give the total quantity of heat generated. By means of delicate automatic machinery the temperature of the room (calorimeter) in which the man is confined is kept constant. All of the heat developed by him is therefore absorbed in the circulating water, and can be measured with the greatest precision.

It is found in this way that the quantity of heat produced by the complete oxidation of a given weight of oil or fat in the body is exactly equivalent to that which would be generated by burning the oil or fat in an apparatus outside of the body. The laboratory apparatus in which foods are actually burned in no way differs in principle from the respiration calorimeter in which a man is placed. It is, however, very much more simple in its construction and more easily operated. The food is burned in a strong steel vessel, which is usually called a "bomb." This steel cylinder is entirely immersed in water, the temperature of which is carefully ascertained before the burning.

Inside of the bomb there are arranged electrical conductors, connected at the point where the food is placed by a piece of soft iron wire. The bomb is filled with oxygen under high pressure. When everything is in place a current of electricity is passed through the iron wire which melts and ignites the food, and the wire and the food are all consumed. The quantity of heat which is produced by the oxidation of the weight of the iron wire is previously ascertained, and this quantity of heat is deducted from the total heat measured by the rise of temperature in the water which envelops the apparatus. The weight of water being known, the rise of temperature, multiplied by the weight of the water, gives the total amount of heat. The external surface of the calorimeter is protected with the greatest care against any changes from the external variations in the atmosphere.

COMPARATIVE FUEL VALUES OF FOODS

By this simple and yet very complicated apparatus the values of foods in producing heat have been accurately determined, both in the big calorimeter where the man lives and in the little steel calorimeter where small quantities of food are

burned. This operation reveals the fact that the quantities of carbohydrates (sugars and starches) and fats or oils which are burned in the body give practically identical quantities of heat with those obtained by burning these products in the laboratory calorimeter. When protein is burned in the body, however, the quantity of heat produced is much less than that obtained in the laboratory calorimeter. This is due to the fact that in the metabolism of protein the end products are not completely oxidized, and thus the total amount of heat that could possibly be developed from the protein is not secured. The most important end product of protein metabolism is urea, and urea can be burned in a calorimeter with the production of an amount of heat equivalent to that which is missing when the protein substance is burned in the body. The study of this fact has led to a knowledge of the exact quantity of heat which the protein furnishes in the body, and which is practically the same as that supplied by an equal weight of carbohydrate (sugar or starch). On the other hand, if the protein is burned in the laboratory calorimeter, the quantity of heat secured is more than one-fourth greater.

An illustration will show better than a descrip-

tion this fact. An average carbohydrate, when burned in a calorimeter, will afford four thousand one hundred heat units, or Calories. The average protein, when burned in a laboratory calorimeter, will give fifty-five hundred Calories. Thus it appears that in every kilogram of protein which is burned in the body there are fifteen hundred Calories of unlocked heat. If this important fact is kept in view, much of the mystery surrounding the descriptions of heat values of foods will be dispelled.

Another important consideration which should be kept in view is the fact that the number of Calories in a food product is expressed on two different bases. In one method the number is expressed on the food as it is consumed, that is, containing no waste material and its usual amount of water. Another method consists in expressing the number of Calories on the food as purchased, and food as purchased generally contains more or less waste material. Meat as furnished contains bone, skin, and gristle. Fruit as purchased contains skin, stem, seeds, and core. Potatoes as purchased contain the skin, which, unfortunately, is commonly removed. Thus, in getting a clear idea of the calorific value of foods for digestive

purposes, the above facts should not be forgotten, and a statement should always accompany a calorific description, whether it refers to the foods as eaten or the foods as purchased.

There is still another method of comparison, namely, to give the Calorie value of the food excluding the water it contains. Very misleading ideas may be acquired if this distinction is not made. For instance, cheese is made of milk. In the manufacture of cheese the greater part of the sugar which the milk contains is excluded. Thus a gallon of milk turned into cheese would not have the food value nor the calorific value of a gallon of milk. Yet the number of Calories in the pound of cheese is very much greater than that in a pound of milk, simply because in the cheese a very large part of the water, as well as the sugar, originally in the milk has been eliminated.

The less water a natural food contains, the greater proportionately is its calorific value. Yet at the same time the food with high calorific value may not be so good a food as the one of low calorific value. Bread as eaten usually contains 35 per cent. of water. The cereal from which the bread is made contains only 12 per cent. of water. Thus the Calorie equivalent of a pound of wheat

is very much higher than the Calorie equivalent of a pound of bread. It is quite unusual to eat the whole wheat, and yet it would give a larger amount of fuel than an equivalent weight of bread. Without keeping this point in view, the intelligent reader not an expert in nutrition might be led to believe that bread is less valuable as a food than wheat.

There is one class of foods in which the theoretical and food calorific values are practically the same. That food is fats or oils. Lard, olive oil, cottonseed oil, and other edible oils, are practically free of water, and hence the number of Calories which they represent is practically secured when used as food. On the other hand, butter contains from 12 to 16 per cent. of moisture. If we look in tables, we will find the calorific equivalent of butter much less than that of olive oil or lard; yet butter has no less food value than these bodies, if expressed on a dry basis. In fact, butter is believed, as the results of late experiments, to contain important elements favoring nutrition, the character of which is not quite well understood, but which favors health and growth. The term "vitamin" was unhappily proposed by Funk to include the peculiar health-giving and

disease-preventing element of the rice grain, which exists chiefly in its outer envelope, and which is lost in the usual process of polishing rice previous to consumption. The special value of butter and some other fats may be due to a similar body.

CALORIES AS A STANDARD OF VALUE

Often the nutritional value of foods is expressed in Calories. This is not physiologically accurate. The Calories express only the heat-producing properties of foods—whereas one of the chief uses of foods is to build tissues and restore waste, functions which cannot be expressed in terms of heat. The heat value of food (in other words, the number of Calories it contains) is the measure of the heat and energy which it will yield, but not by any means the measure of its nutritive value.

Digestion is a term applied to the various chemical changes which take place in the foods after the process of mastication is completed. The process of digestion, in a limited sense, consists of those processes which render the foods soluble and suitable to be absorbed into the blood-current.

Enzymes, from a physiological point of view, in regard to the digestion of foods, are the organ-

isms which are active in liquefying the food. They are of several classes, namely:

a. Amylolytic.—Enzymes which liquefy starch. The saliva contains an enzyme of this kind, ptyalin, which converts starch into sugar. The pancreas also secretes a similar enzyme, amylopsin. Invertase is an enzyme which converts sugar into dextrose and levulose.

b. Proteolytic.—Pepsin, the enzyme secreted chiefly by the coats of the stomach, the function of which is to reduce the insoluble proteins to a soluble state, is typically proteolytic. Trypsin secreted by the pancreas is supplemental to pepsin. The proteoses (albumoses, peptones) produced by pepsin digestion are reduced to amino-acids by trypsin and erepsin.

c. Lipolytic.—The enzyme secreted chiefly by the pancreas, the function of which is to render fats suitable for absorption into the blood-current. It splits the fats into glycerin and fat acids. The pancreatic secretion is the most important of the digestive agents, since it contains three ferments, viz., amylopsin, trypsin, and lipase, attacking starch, protein, and fat, respectively. The secretion from the liver (gall) also is active in the digestive activities of the small intestine.

THE PROCESSES OF NUTRITION

The three kinds of enzymes mentioned above are sufficient to render soluble and suitable for absorption the various kinds of food taken into the stomach. The chief object of chewing is to reduce all foods to a fineness suitable to favor the action of the enzymes. Starches and foods containing cellulose require much more complete mastication than do meats, which contain chiefly protein substances. As an aid to digestion all foods should be carefully masticated, especially those of a starchy or fibrous character. The sum of the changes which take place before the food products enter the blood-current constitutes the process of digestion, in the ordinary application of the term.

Assimilation is a term applied to the selective action of the tissues of the body in taking up from the blood-current the particular foods which nourish them and restore their wasted particles.

Excretion, the opposite of assimilation, is a term applied to the process by means of which the cells that have performed their function are degraded, often rendered soluble, and in this state made suitable for removal from the body through the vari-

ous organs, such as the skin, the alimentary tract, and the kidneys. The residual parts of the food which do not enter into the living tissues after being wholly or partially burned (water, carbon dioxid, urea, etc.) are excreted in like manner.

Metabolism is a term applied to the sum total of the changes which take place in digestion, assimilation, and excretion. The process of metabolism is made up of two distinct stages; namely, *anabolism*, the building up of the tissues, and *catabolism*, the tearing down of the tissues.

Foods, in a legal sense, have been defined by act of Congress to include the substances commonly known as foods, and also beverages and condiments. Under this definition, foods include water, soft drinks, all alcoholic beverages, and salt, vinegar, spices, flavors, and other condiments.

Difference between Plant and Animal Foods: There is no sharp biological line which distinguishes between plant and animal life. The best line of separation is the character of their food. Plants eat inorganic, animals organic, foods. An organic food is furnished by a living being, such as an apple, a product of plant life, or a beefsteak, a product of animal life. On the other hand, a stone or a metal is not formed by biological

processes; they are inorganic. Plants live almost exclusively on inorganic materials, such as potash, lime, phosphates, nitrates and iron. Animals, on the other hand, cannot be directly nourished by such foods, but feed on plants or on other animals. There are perhaps a few exceptions to this rule, as, for instance, certain fungi, such as mushrooms, which are plants, and yet, according to some authorities, live to some extent on organic matters, while animals require salt, which is an inorganic substance, as a part of their food. Other inorganic substances, in the form of phosphates and lime compounds, are capable of aiding nutrition. In general, it may be said that, with the exception of salt, all the mineral nutrients of the body may be found in their proper quantities in biological combination in the normal food of man.

When man in a state of health is properly fed, the only mineral ingredients that should be added to his food are chlorid of sodium (common salt), and not much of that, and the natural mineral constituents of good water, which he drinks and with which his food is cooked. In disease conditions other mineral substances may be indicated, but these should be used only under the direction of a competent physician.

WHAT PLANTS DO

Plants absorb from the soil the soluble salts of lime, phosphorus, potash, compounds of nitric acid, water, and carbon dioxid (when united with water, carbonic acid), and elaborate (change into utilizable condition) oxygen, protein, starch, sugar, cellulose, fat or oil, citric, tartaric, and other organic acids, essential oils, and many other minor organic products. Animals cannot produce any of these compounds from inorganic foods. Animals eat these plants and other animals, and make new kinds of protein, bone tissue, fats, etc., which are more or less characteristic for each species.

The animal differs chiefly from the plant in that it produces in health only a trace of a carbohydrate (glycogen) and sugars derived from protein, and no starch or cellulose, whereas the chief products of plant life are carbohydrates. It is only in a diseased state (diabetes) that man secretes sugar, and never starch. On the other hand, sugar and starch are important products of all plant life, and in some cases, as with the potato, sugar-cane, sugar-beet, maple, etc., represent their chief economic value.

In respect of the character of their foods, animals are of three kinds, viz., those living exclusively on plants, those living exclusively on animals, and those living on a mixed diet. The terms herbivorous, carnivorous, and omnivorous, are applied to them, respectively. Of common animals the sheep and the cow are types of the herbivorous, the dog and cat of the carnivorous, and man is the omnivorous animal. But flesh-eating animals may be fed more or less completely on a vegetable diet. The cat and the dog would eat no vegetable foods from choice, but often do so from necessity. Probably there is no carnivorous animal that would not eat plant products rather than starve. On the other hand, it is doubtful if many plant-eating animals would eat meat under any circumstances. The sheep, especially, would refuse any flesh diet. The pig is supposed to be vegetarian, but is very fond of a limited meat diet. The most scientific feeders daily give the hog a small quantity of meat meal. Omnivorous animals like man can subsist very well on an exclusively vegetable diet, but would not thrive well on an exclusively meat diet. This fact shows man to be omnivorous in a limited degree. He can eat everything that is

fit, but decidedly prefers a diet largely vegetable.

A MATTER OF ADAPTATION

If we admit that man is a creature of heredity and environment, we should expect the diet of man to depend largely on vegetable foods. This is found to be the case. Where vegetation is abundant and perennial, man's natural diet is decidedly vegetable, as in tropical regions. In the far North for similar reasons it is decidedly animal, as among the Eskimos. In the temperate zones we find the diet mixed, with a decided tendency to fruits and nuts toward the south, and an increasing consumption of fat, flesh, and fish toward the north. The most progressive type of man is found in the temperate zones. While diet is by no means the sole cause of this difference, it plays an important rôle in that environment which conditions the best evolutionary medium of man.

The facts of comparative anatomy show differences of structure between purely vegetarian and purely meat-eating animals. Compare, for instance, the bovine and feline types. The cow has only one set of incisors, well suited to gathering grass, but useless for seizing and holding the vic-

tims of prey. On the other hand, the lion would cut a sorry figure grazing on the meadow. The molars, or grinding teeth, are also quite different in the two types, the one with broad surfaces and both a perpendicular and a lateral motion of the lower jaw, the other with more pointed surfaces and a single motion. There is also a marked difference in the duration of mastication. In the cow it is slow and laborious, in the tiger quick and easy. In fact, the meat-eating animals chew only to swallow, while the vegetable-eating animals chew to digest. The contrast is continued in the digestive organs; the first type has one or more stomachs of comparatively large size and greater area of digestive surface, the other has a restricted digestive surface and a shorter alimentary canal. With the herbivore eating is a business, with the carnivore it is an incident, employing but little time.

Judged by the standard of comparative anatomy, man is both herbivorous and carnivorous.

For this reason, the normal diet of man should be mixed, but predominantly vegetable. This is advantageous not only physiologically, but also for economical reasons. A vegetable diet in which cereals play a dominant rôle costs much

less than a diet in which meats are in excess. In many diseased states of the body a more exclusive diet is often indicated. Milk is the only food tolerated in some cases, while in others, such as tuberculosis, many physicians believe that eggs and lean fresh meat should constitute the principal diet.

But far more convincing than this is the fact that in all countries and in all ages of civilization man by choice, with only a few exceptions, is, and has been, omnivorous. This fact will remain the chief reason, until human nature changes, for eating moderately of all classes of foods.

LESSON III

PROTEINS

THOSE compounds of animal and vegetable origin which contain as essential ingredients nitrogen and sulphur are commonly known as proteins.

The composition of protein varies with its character and origin. Its chief constituents occur in approximately the following proportions:

Carbon	52	per cent.
Oxygen	22	" "
Nitrogen	17	" "
Hydrogen	7	" "
Sulphur	1	" "

Hemoglobin, a protein found in blood, contains a little iron.

Some nitrogenous substances, as nuclein and lecithin, also contain phosphorus. The foods containing protein are unique in the process of digestion. Together with certain mineral matters, particularly lime and phosphorus, they form the sole building materials of the body for all the tissues, with the possible exception of fat. The

phenomenon of growth is, therefore, associated most intimately with protein and mineral foods. On the other hand, the phenomena of the production of heat and energy are chiefly associated with carbohydrates and fats in the food, although the protein foods take an important and yet secondary rôle in the production of heat and energy. Great progress has been made in the last few years in our knowledge of the rôle of protein in the animal organism.

THE FUNCTIONS OF NITROGEN

The cycle of nitrogen in nutrition of animals and plants is one of the most interesting and important studies in nutritional physiology. We may trace the nitrogen from its condition as an inert gas in the air. Apparently it has few or no affinities in so far as we are able to detect them by our usual methods of observation. Four-fifths of the atmosphere consists of nitrogen, a gas which moves in this immense ocean over the surface of the earth, penetrates every crack and cranny of the earth's porous surface, extends to an indefinite height, exists in direct contact with oxygen without any tendency to unite therewith, and seems to mock the efforts of man to utilize it

except according to its own sweet will. Nitrogenous foods are among the most expensive which we have to purchase. Nitrogenous fertilizers, except at the present time of war, when the price of potash has been greatly increased, are the most expensive of the fertilizers which the farmer must procure for his growing crops.

It is only within thirty or forty years that scientific investigators have discovered that a certain family of plants, and possibly others not yet known, has the faculty of elaborating nitrogen and converting it into protein substances in the plant. This plant family is the legume. Some common members of this family are well known, such as the pea, the bean, the lentil, all forms of clovers, including the red clover, white clover, alsike and alfalfa, the peanut and the locust tree. The method by which this synthesis of nitrogen is accomplished is through the activity of microorganisms of a low vegetable character which live upon the roots of leguminous plants. It seems to be a rule that they live in symbiosis with this family of plants, since their activities are not extended to the roots of other plant families in so far as known. Nesting on these roots in houses of nodules, they erect their tiny laboratories and

proceed to manufacture nitric acid, which in turn is assimilated by the plant into protein. The well-known fact that the growing of leguminous crops increases the fertility of the soil is thus explained. Large quantities of the residual nitrogen made in this way are stored in the roots and stubbles, to be utilized when the field is next plowed for the growth of corn and wheat. To secure the maximum yield of fertilization the whole plant may be plowed into the soil just before reaching its maturity. Thus comparatively poor fields may be transformed into rich and productive soil, in which it would be necessary only to supply the requisite quantities of phosphoric acid and potash.

Instigated by nature's success along these lines, man has contrived to utilize considerable quantities of nitrogen by purely chemical means. When an electric discharge is conducted through the air traces of nitrous and nitric acid are always produced, that is, the high temperature of the electric wave in its translation through the air causes a certain quantity of oxygen and nitrogen to unite. This union, plus water, forms nitrous and nitric acid. Utilizing waste waterfalls for the production of large units of electricity, suc-

cessful attempts have been made to manufacture nitric acid or its compounds on a large scale for use in the arts and for fertilizing soils. While this process has not yet succeeded in making nitrogen any cheaper than the stores which nature has preserved for human use, it is becoming more efficient every day, and it is clear that the time is not far distant when nitrogen may be manufactured in this synthetic way at a lower price than it is necessary to pay for it from the ordinary stores.

The animal, however, cannot use mineral nitrogen. It does not assimilate ammonia, nitrous acid or nitrites, or nitric acid or nitrates, and these are the only forms in which atmospheric nitrogen is synthetically utilized by plants. These products must pass through the organism of the plant before they become suitable for animal food. Thus synthetic nitrogen products are first used in promoting plant growth, and then find their way into the nutritive stores for animals. The quantities of nitrogen are so vast and the activities of micro-organisms in restoring it to the atmosphere so continuous that there is no danger of diminishing by any perceptible amount the nitrogenous content of the air by all the factories

manufacturing synthetic nitrogen by any chemical processes.

VEGETABLE PROTEINS

The proteins are the most useful tissue-builders of all nitrogenous foods. There are other foods which contain nitrogen, and which are to some extent allied in character to proteins, but which are by no means so nutritious. What are known as flesh-bases or meat-extracts are examples of foods of this character. They are largely condimental rather than nutritious. The so-called meat-extracts of commerce, when properly made, and the bouillon cubes which are now largely sold, are types of this latter class of nitrogenous matter. Generally speaking, the proteins, especially in meat and eggs, are the most expensive forms of foods, but vegetable proteins are cheaper, and the object of the present lesson in nutrition is to call attention to the vegetable foods which particularly yield proteins, and are, therefore, typically the builders of nitrogenous tissues; namely, the muscles, the nerves, the brain, and the organic constituents of the bones.

The vegetable proteins, while resembling one another very closely in chemical composition,

have distinctive characters for each particular plant. While these characters are not strikingly differentiated, they are sufficiently different to enable the expert to distinguish one kind of protein from another. They also differ from one another in their nutritive values, some proteins, like those of milk, being more completely digested than some others, such as those of vegetables and cereals. These differences in digestive properties are not so marked as to warrant any very great discrimination in the choice of various foods, so far as their nitrogenous content is concerned, except in cases of disordered digestion and disease.

First of all, it must be borne in mind that the elements nitrogen, phosphorus, and sulphur, which are characteristic components of proteins, and phosphorus, which exists in nucleins, do not exist as such in these combinations, but in organic form, where they have practically none of the physical properties that are possessed by the element nitrogen, sulphur, or phosphorus. It has often been urged by those who would use the fumes of burning sulphur in food products that inasmuch as nature has placed sulphur in foods, it is not an adulteration for art to add a little to the quantity. The sulphur which exists in com-

bination with the other elements of protein in foods is quite a different substance from the sulphur which exists in the form of sulphur dioxid. In the one case it is a natural and essential food product, providing the digestive organs with a source of the sulphur which is built into the tissues of the body; in the second instance, it is an inorganic, poisonous compound which has no function whatever in the processes of nutrition.

THE GREATEST BODY-BUILDER

In calling attention to foods which are rich in protein, wheat naturally takes the first place. Wheat is a complete food in itself, containing nearly all the elements necessary to human nutrition. The wheat crop is divided into two kinds: first, that which is sown in the fall and lives through the winter, and, second, that which is sown in the spring. While these wheats are not essentially different, as a rule the fall-grown wheats are more plump, starchy, and of a softer character, while the spring-grown wheats are generally hard and flinty, and more nitrogenous in character. The average farm price for wheat in time of peace is about eighty-eight cents per bushel of sixty pounds, so that it and its products

are, or should be, the cheapest as well as the best balanced and most nutritious foods which can be used in the American household.

If an abundant supply of milk, yielding basic ingredients, can be had with wheat, the diet is ideal.

The average amount of protein in wheat is 12.25 per cent. A bushel of wheat weighing sixty pounds would, therefore, contain 7.35 pounds of protein. The price of protein in cereals is lower than in any other important food. Aside from its nutritive importance, the protein of wheat has a technical value. The greater portion of it is what is commonly known as gluten. Gluten, as such, does not exist in wheat, but the moment flour is moistened, two of the proteins which it contains—namely, gliadin and glutenin—combine to form the product known as gluten. When saturated with water, the gluten increases its weight two and one-half fold, so that the weight of moist gluten obtained is two and one-half times as great as that of the dry ingredients from which it is made.

PROTEIN AND GLUTEN

The gluten in wheat formed by aid of water from glutenin and gliadin is valuable from a technical point of view by reason of its forming a tough, elastic mass, which is well exemplified in the ordinary dough of the baker. It is this property which gives to white flour its technical value for baking purposes above that of the flour of any other cereal. There are other cereals, such as oats, that have a higher content of protein, but there is no other cereal which begins to compare with wheat in its technical uses as an ideal substance for making bread. To the gluten of wheat the dough owes its property of elasticity, of ability to rise and make a light loaf. This is due to the entanglement of the particles of the leavening gas in the meshes of the elastic gluten. The leavening of wheat flour and other products depends upon the introduction into the mass of dough of a gaseous substance, which, when expanded by heat, produces the lightness of the loaf.

Speaking in round numbers, ten-twelfths of all the protein of wheat is gluten. In the bran there is a larger percentage of protein than in the interior of the grain; but this protein is not all

gluten or gluten-forming materials. The gluten of wheat is easily digestible, thus giving to wheat bread one of its high qualities as a nourishing medium. While it would not be sound nutrition to advise an exclusive cereal diet, it is both nutritionally and economically sound to urge upon the American housekeeper the advisability of a larger percentage of wheat products in the home dietary. Personally I prefer the whole ground wheat, especially that ground upon an old-fashioned millstone, which reduces the bran to fine particles. A few authorities are quite of the opinion that the white flour is superior for dietetic purposes, but I think that the whole-wheat flour for wholesomeness, as well as for nutritive purposes, is to be preferred.

But this is not the point at the present time. What I desire particularly is to urge upon the American housekeeper, in order to reduce the cost of living, to make wheat, together with other cereals, a large part of the diet.

PROTEIN IN OTHER CEREALS

The amount of protein found in other cereals, in round numbers, is as follows: In Indian corn, 10 per cent. The principal protein of Indian

corn, known as zein, does not by any means have the plasticity and elasticity of gluten. The zein of Indian cornmeal does not seem to be quite so wholesome as the protein of wheat. It is difficult, however, to separate the proteins of cereals in sufficient quantities to enable feeding experiments on a large scale to be made. Indian corn is wholesome and nutritious. There are many experts, especially in Europe, who think it is unfit for food, but it is used in the United States almost as extensively as wheat flour. A bushel of corn weighs fifty-six pounds, and contains 5.6 pounds of protein.

In rye the average content of protein is the same as that of wheat, 12.25 per cent. The protein of rye is chiefly composed of the bodies known as leucosin, gliadin, and edestin. In many parts of Europe, especially in Russia and Germany, rye is the principal cereal food. It is not very extensively used in the United States, except by our foreign-born citizens. The protein of rye is a wholesome, digestible body, and as far as tissue-building is concerned is probably almost as valuable as wheat protein. Rye flour as examined by the Department of Agriculture has a very low content of protein. Since rye and Indian corn

are generally a little cheaper than wheat, some economy in the diet will be secured by a more general use of these products. As a balanced ration neither can quite take the place of wheat.

Of the common cereals in use for food purposes, hulled oats has the highest protein content; namely, about 14.5 per cent. In a given weight of hulled oats the housekeeper will be able to purchase more protein per pound than in either wheat or rye. The protein of oats is quite deficient in agglutinating power, and, therefore, for bread-making it cannot be compared to wheat. It makes, however, an excellent breakfast diet.

Barley is not used in this country to any extent for food purposes, except in the form of malt, for modifying infants' diet, and in soups. Its percentage of protein is almost that of wheat, and there is no evidence to show that for nutritive purposes and digestibility it is inferior to the protein of other cereals. The principal protein of barley is hordein.

Buckwheat, when hulled, produces a flour which has an excess of carbohydrates. The protein content of the hulled buckwheat flour is only about 8.75 per cent. A coarser flour with less bolting is advisable, and this coarser, unbolted flour will

have almost 10 per cent. of protein. Buckwheat is not to be advised as a daily diet, but it is palatable at times, and nutritious and wholesome.

Of all the cereals, rice contains the least protein. It is essentially a starchy food. Unpolished rice, which is the only kind that ought to be eaten, has a mean protein content of about 8 per cent., while a polished rice, from which the outer bran has been removed, has a mean protein content of about 7 per cent. Rice bran has a mean protein content of about 12 per cent., being almost as rich as wheat.

MACARONI AND SPAGHETTI

Among the by-products of cereals which are rich in protein, one of the most important is macaroni, with which may be closely associated a similar variety of foods known as noodles and spaghetti. The average amount of protein in these products is a little over 12 per cent. They are usually made from wheat rich in protein, and are wholesome, nutritious, and palatable. These foods have about twice as much mineral matter in them as ordinary fine white flour. In other words, they contain about two-thirds of the total mineral matter found in wheat itself. Hence, as a source

of protein in cereal products, where a rich nitrogenous diet is desired, materials of this kind are preferable to white flour.

THE LEGUMINOUS VEGETABLES

There are other vegetable substances which are rich in protein. Among these may be mentioned first, as of greatest importance, the different members of the leguminous family; namely, peas, beans, lentils, etc. Green peas contain about 80 per cent. of water, and, therefore, the comparative percentage of protein is not very high, being a little less than 4 per cent. The dry pea, however, which contains only 4 per cent. of water, has 27 per cent. of protein, more than twice as much as average wheat-flour. If a vegetable diet rich in protein be desired, it can be better provided by the pea than by the best wheat bread. As a balanced diet, however, for complete nutrition, wheat is preferable to the pea.

Closely related to the pea in chemical composition is the bean. Fresh string-beans have over 85 per cent. of water, and only 2.20 per cent. of protein. The dry bean, containing 16 per cent. of water, has 21 per cent. of protein. Some varieties of bean, like the lima, are even richer in protein.

Lima beans, with 68 per cent. of water, contain 7.15 per cent. of protein. If green beans are served with the pod, as is usually the case, the content of protein is correspondingly reduced. Leguminous bodies, such as the pea, bean, and lentil, are nutritious and desirable articles of food, especially when the quantity of protein in proportion to the whole amount of food is to be increased. In those conditions of disease where starch and sugar should be eliminated, the vegetables containing them can be very advantageously supplanted by peas, beans, and lentils.

NUT PROTEIN

Ordinary nuts are very rich in nitrogenous matter. The percentage of protein in the edible portion of nuts varies greatly with the variety. For instance, the peanut has about 30 per cent. of protein, while the chestnut has only a little over 6 per cent. The almond, which is so great a favorite for eating, has a little over 21 per cent. of protein.

After the oil has been extracted from nuts, the proportionate amount of protein in the resulting cake is increased. For instance, in the case of almonds from which the oil has been extracted, the resulting almond-meal has over 50 per cent.

of protein. Unless one dislikes the excessive amount of oil in nuts, their consumption affords a fine supply of protein in a highly palatable and nutritious form. Unfortunately, many stomachs cannot tolerate excessive quantities of fat or oil. In cases where there is a tendency to obesity, the eating of legumes and nuts to secure the supply of protein is better than the consumption of cereals or cereal preparations, such as macaroni. The nut, however, is not a balanced diet, and its excessive consumption is likely, sooner or later, to derange digestion.

There are other less important vegetable foods which contain notable quantities of protein. The common vegetables and fruits are deficient in protein, and could not be recommended as a source of nitrogenous diet. While vegetables and fruits are extremely wholesome and almost indispensable to the proper nutrition of the body, they are sources of supply for heat and energy rather than for the building of tissues, yet all of them contain considerable quantities of tissue-building materials in the form of protein and mineral salts. Their chief dietetic value lies in the sugar or starch, minerals and acids which they contain.

LESSON IV

ANIMAL PROTEINS

MILK

ONE of the most important sources of protein, in so far as human nutrition is concerned, is found in milk. The milk of the human mammal is the least constant in composition of any, partly because of the mother's artificial and unnatural environment and her more complicated nervous and emotional make-up, and for this reason it is difficult to arrive at an accurate average of its composition for comparison with the average milk of the cow. However, the data given here were compiled from the supplies furnished a large hospital, and can be regarded as approximately correct:

	Human Milk. Per Cent.	Cow's Milk. Per cent.
Fat	4.00	4.00
Milk-sugar	7.00	4.50
Proteins	1.50	3.50
Mineral salts	0.25	0.75

It is seen that there are important variations between these two milks in their quantities of

sugar, protein, and mineral salts. Human milk has a large excess of milk-sugar and a marked deficiency of protein, as compared with the milk of the cow. More striking still is the difference in the content of mineral salts, the milk of the cow having three times as much as human milk.

This difference in composition is of the utmost importance in regard to the protein food of the infant. A study of the digestive excretions of the infant shows that they are deficient in hydrochloric acid, the presence of which is important in the digestion of protein. The human infant, therefore, should not be called upon to digest as much protein in proportion to its diet as the young of other mammals. Hence the modification of other milks as a substitute for human milk especially necessitates diminishing the quantities of protein and minerals, and increasing the quantity of milk-sugar. This modification can be accomplished only by experts with accurate facilities of measurement and analysis. The dilution of cow's milk with water, so as to double its volume, would give to the infant approximately the quantity of protein found in the normal milk of its mother; but this would also reduce all the other constituents in the same proportion. The protein

of milk is probably more completely digested than that from any other source, especially by infants, invalids, and the aged. Milk must be regarded, therefore, as the fundamental source of protein for the human animal, and especially for its young.

Farmers' Bulletin No. 363, United States Department of Agriculture, "The Use of Milk as Food," gives a mass of simply presented data and diagrams on the comparative nutritive value of milk and other foods, which will prove of value to those wishing to look further into this matter.

CHEESE

From milk is derived cheese, a most valuable food product as far as protein is concerned. Although dozens of different varieties of cheese are made in different ways and have different flavors, practically all have the same nutritive properties. Among typical varieties, Roquefort contains 22.6 per cent. of protein, and yields a little over 1,700 units of energy (Calories) per pound; Swiss cheese contains 28 per cent. of protein and 34.09 per cent. of fat, a pound yielding a little over 2,000 units of energy; while American full-cream cheese has 25.9 per cent. of protein and 33.7 per

cent. of fat, yielding 1,950 units of energy per pound.

Farmers' Bulletin No. 487, on "Cheese and Its Economical Uses in the Diet," caused something of a furore over this product, which supplies slightly more protein for the money than any food except wheat. Relative digestibility must, however, be considered. Shortly after the appearance of this bulletin a newspaper told of a workman who, becoming unduly enthusiastic over the government's account of the desirability of cheese as a cheap nutritive food, purchased a couple of pounds, consumed them at one sitting, and died forthwith—a warning, even if only a fairy tale, to all dietetic faddists who distort simple facts out of all proportion! Nevertheless, eaten in reasonable quantities, cheese is not so indigestible as has been thought, and under normal conditions does not cause constipation and other physiological disturbances which have been attributed to it.

EGGS

The white of the egg is the ideal source of protein, so far as purity and digestibility are concerned. The dry substances of an egg consist

essentially of protein and fat, the protein being in excess. When fresh, the egg contains a little over 70 per cent. of water. The 28 per cent. of solid matter is composed of 13.5 per cent. protein, 12 per cent. fat, 1 per cent. ash, and 1.5 per cent. unnamed. The protein of the egg is easily assimilated, and fresh eggs will promote growth, and at the same time, by reason of the large percentage of fat that they contain, furnish a very large amount of heat and energy.

The white of an egg consists almost entirely of water (86 per cent.), and 12 per cent. is a protein soluble in water, known as albumen. On the other hand, the yolk of an egg, which contains about 15 per cent. of protein, has also a large percentage of fat (33 per cent.), and only 50 per cent. of water. A phosphorus-holding body containing nitrogen, allied to the proteins and yet quite different in its dietetic purposes, is an important constituent of the yolk. This substance, called lecithin, contains phosphorus in a form peculiarly adapted for assimilation and for the nourishment of the phosphatic tissues of the body, among which the bones and teeth are the most important. Many so-called nerve or brain foods lay much stress on the lecithins, nucleins, etc.,

which they contain, but none of them can approach milk, eggs, and whole cereals as sources of these important nutrients. The yolk of an egg is a much more complete food than the white, by reason of the fat, phosphorus, and lime which it contains, but the white is more nearly pure protein than any other food available for human consumption. A hen's egg, shelled, weighs about 50 grams (1.7 ounces). Farmers' Bulletin No. 128, "Eggs and Their Uses as Food," United States Department of Agriculture, will help the housewife to make an accurate estimate of the place of eggs in the diet from both an economical and a dietetic point of view.

LEAN MEAT

Lean meat is one of the most abundant sources of protein. The leanest loin of beef may be regarded as typical of the lean meat of bovine animals. This consists of about 70 per cent. water and 30 per cent. food material. The average protein content of the loin, the edible portion, when deprived of all visible fat, is 25 per cent., its content of fat 3.7 per cent., and of ash 1.3 per cent. Each pound yields about 615 units (Calories) of energy or heat. The loin is the typical protein

part of the beef, and contains more protein per pound than eggs. But as, in beef usually presented for consumption, the lean is mixed with more or less fat, the relative quantity of available protein is very much less. The approximate composition of the fat loin is: water, 55 per cent.; protein, 18 per cent.; fat, 28 per cent.; mineral matter, 1 per cent. A pound of such loin would yield 1,490 units of energy, the increase coming solely from the larger amount of fat.

Mutton does not differ largely from beef in chemical composition. With the fat which is usually attached to it, the loin consists of 50 per cent. water, 16 per cent. protein, 33 per cent. fat, and 1 per cent. mineral matter, a pound of it yielding 1,700 units of energy. Loin of pork, considering only the edible portions, as is done in all of these cases, contains 52 per cent. moisture, 16.5 per cent. protein, 30 per cent. fat, and 1 per cent. mineral matter, a pound of it yielding 1,600 units of energy.

Sausage, of which pork sausage may be taken as typical, contains 40 per cent. moisture, 13 per cent. protein, and 44 per cent. fat. A pound of sausage of this composition furnishes 2,150 units of energy. The sausage made from other animals

varies somewhat from this, but the variations in the quantity of protein are not important.

The protein of fowls is an important item of nutrition. In grown chickens the edible parts contain 64 per cent. water, 19 per cent. protein, 16 per cent. fat, and 1 per cent. mineral matter, each pound supplying 1,050 units of energy. In the case of turkey, the edible portions of the meat contain 56 per cent. water, 21 per cent. protein, 23 per cent. fat, and 1 per cent. mineral matter, each pound furnishing 1,360 units of energy.

FISH

In fish is found a food product particularly rich in nitrogenous material. The edible portions of the bass, which may be taken as a fairly representative fish, contain 77 per cent. water, 21 per cent. protein, 1.7 per cent. fat, and 1.2 per cent. mineral matter. By reason of the high content of moisture and the low content of fat, a pound of black bass yields only 450 units of energy a pound, of cod 325 units, and a pound of herring 660 units.

Shell-fish, such as the oyster, contain very high percentages of water. The edible portion of the oyster contains 87 per cent. water, 6.2 per cent. protein, 1.2 per cent. fat, 2 per cent. mineral mat-

ter, and a pound yields only 235 units of energy. Lobster, edible portion, contains 78 per cent. moisture, 18.1 per cent. protein, 1.1 per cent. fat, 2.5 per cent. mineral matter, a pound yielding 390 units of energy.

The above analytical data are approximate figures from which single samples may greatly vary.

GELATINES AND MEAT EXTRACTS

Gelatines contain a considerable quantity of protein, the average dry gelatine having 91.4 per cent. and yielding 1,700 units of energy per pound. But a product like calf's-foot jelly, as purchased ready for use, contains only 4.3 per cent. of protein, and a pound of it yields only 405 units of energy.

It must be remembered that gelatine in the form in which it is eaten has been much diluted, and, therefore, its actual food-value is not as great as the analysis would seem to indicate. Unfortunately, the line between glues and gelatines is often carelessly drawn, and while the standard brands of gelatine are rendered harmless by the process to which they are submitted, the raw materials from which they are made are often open to suspicion. Tendons, bones, sinews, and skins

are used in making gelatines, and the temptation to use material that is not sanitary for food purposes is great. The product has, however, been greatly improved, especially in the manufacturing part of the process, under the food law. The protein of gelatines yields a very poor quality of tissue-building materials, and for this reason gelatines are not valuable for food products.

FOOD VALUE OF MEAT EXTRACTS

The public has been so completely misled as to the nature of meat extracts, bouillon cubes, etc., that it is difficult to re-educate people. One naturally thinks that an extract is a strong, concentrated juice, so that the name itself is misleading, while extravagant advertising claims have strengthened an already false impression. As a matter of fact, these products are valuable stimulants or flavoring agents, but have little or no real food-value. The coagulable protein or muscle-building part of the meat is almost entirely lacking. Furthermore, the bouillon cubes contain from 49 to 72 per cent. of salt. These products have a legitimate place as stimulating, soothing beverages; they give a pleasant flavor to a cup of hot water, and often are both convenient and

useful, but they must not be depended upon for a child's luncheon, nor for any occasion when a nutritive food is needed.

These data give a general idea of the amounts of protein found in animal products. Chemical analysis shows very little difference between the food properties of the proteins of animal origin and those of vegetable origin. There are, however, very grave differences due to other considerations. Man, being by nature an omnivorous animal, does not, as a rule, confine himself to any one article of food, and so the protein, both of animal and vegetable foods, is uniformly associated with other food substances. Starving man is by instinct carnivorous rather than herbivorous. Admiral Peary reports that while he and his men were on half-rations during their long forced marches their hunger was for warm flesh foods. Some vegetarians do not hesitate to employ the animal proteins represented by milk and eggs. In this sense, therefore, many vegetarians are not, strictly speaking, properly labeled.

The housekeeper serves her household best if she provides such a variety of protein-containing foods as not only insures the proper nourishment of the body-tissues, but at the same time appeals

to the sense of taste and excites the appetite. The flow of the saliva and the gastric juices, on which digestion and assimilation largely depend, is materially assisted by pleasing flavors and the odors of appetizing foods. For this reason a mixed diet, containing both vegetable and animal proteins, seems to be the most reasonable and usually the most desirable. This is not gainsaying that the average person eats too much meat. Especially those who take but little exercise could cut down the total amount of protein with benefit, and also could profitably obtain more of it from beans, peas, cheese, and milk, and less from meat.

In this connection it may not be out of place to call attention to the vital part that a "merry heart" plays in promoting digestion. In the *Journal* of the American Medical Association the sweeping statement was made not long ago that it would be better for a nervous patient to eat the foods least adapted to his condition under cheerful circumstances and with a light heart, than to consume a scientifically adapted ration under depressing conditions. The nerves largely control digestion and assimilation and the flow of the digestive juices, and the old Biblical proverb, "Better a dinner of herbs where love is than a

stalled ox and hatred therewith," is just as good dietetics today as it was three thousand years ago.

QUANTITY AND COMPARATIVE COST OF PROTEINS

A person weighing 150 pounds and engaged in moderate exercise, such as is typical of clerical and other similar services, requires about 100 grams (3.5 ounces) of water-free protein per day. The expression "water-free protein" must not be construed to mean protein deprived of its water. Many soluble proteins in such form would be injured for digestive purposes. The protein is to be ingested with its usual content of moisture, but the quantity of it is to be calculated to a moisture-free basis. For body weights above or below 150 pounds, proportionately larger or smaller quantities of protein are required. For those engaged in medium hard labor or hard manual labor a somewhat larger quantity per pound of body weight is necessary.

Of the sources from which the required daily amount of protein may be derived, the cheapest are vegetable substances, such as wheat and other cereals, peas and other legumes. The average person weighing 150 pounds, doing light labor,

eats 1 per cent. of his weight of dry food per day; in other words, one pound and a half. If he should live entirely upon wheat bread, he would require about three one-pound loaves, nearly half of the weight of loaf-bread being water, shortening, and mineral substances, such as salt, baking powder, etc. The three pounds of bread, which give him just a little over 100 grams of protein, would cost 15 cents. We may approximately rate the protein in the bread at one-third of its total cost. Thus, if one depended on the protein of wheat bread alone, it would cost about five cents per day.

Contrast this with loin of beef, which today retails at about 25 cents a pound. This beef contains 25 per cent. protein. A pound of loin, all edible, would supply 113 grams of protein, just a little more than the estimated daily requirement. Thus protein derived from this cut of beef, containing no bone and the merest trace of fat, costs five times as much as the protein derived from bread; and the contrast becomes even more marked with porterhouse steak, approximately half of which is bone and refuse material. The cost of protein, as a rule, is less in fish than in beef, but in poultry, especially young poultry, it is

often greater, while in peas and beans it is, as a rule, slightly greater than it is in wheat.

In order to secure 100 grams of protein from eggs, $1\frac{2}{3}$ pounds must be eaten. Eight eggs average a pound. Allowing for the weight of the shells, it would take at least 15 eggs to furnish 100 grams of protein. With eggs at 40 cents a dozen, this would mean 50 cents' worth. One-half of this cost, or 25 cents, may be charged to protein. If the protein required for the day's ration be derived from milk alone, it would take considerably over three quarts to furnish the required amount, which, at 10 cents per quart, would cost approximately 35 cents, one-third of which may be charged to protein.

BALANCING THE DIET

Inasmuch as whole wheat is a most wholesome food in various forms, and can be used as bread, as porridge or mush, and as hot rolls, it is desirable, both economically and nutritively, to use generous quantities of cereals, especially wheat, in our dietary. Other cereals are perfectly wholesome, and furnish well-balanced diets, thus admitting of agreeable variations, without notably

affecting the sources of nitrogen supply or increasing the cost of the diet.

The quantity of protein needed by growing children in proportion to their weight is considerably greater than that required for the adult, while that necessary to old people is considerably less. An infant that is well nourished doubles its weight in six months, thus requiring a very much larger ingestion of food per unit of weight than an older child or an adult.

HOW MUCH PROTEIN?

The question of how much protein should enter into the composition of our diet is one that has been vigorously and ably discussed. On the one hand, we have the school of Chittenden and Fisher, advocating a much lower percentage of protein in the diet than is found at the present time. On the other hand, we have the arguments of Benedict and James Creighton Brown in opposition to the proposed reduction of the percentage of protein. When eminent investigators, fully competent by reason of their training and experience to pass an opinion worth while, disagree, it is safe for the ordinary individual to take the middle ground. Extensive study of dietaries

in different parts of the world and in different occupations reveals one unmistakable tendency. In temperate regions where the conditions of life are hard, where poverty prevails, and especially where there seems to be little ambition for better things, we find always a diet in which the quantities of protein are lowered and the quantities of carbohydrates increased. Fat usually follows protein in this forced choice of a diet. We may, without bias, consider what happens in a diet of this kind, followed sometimes through the entire life of the individual and among large numbers and classes of persons.

DIET AND MILITARY FITNESS

In those countries where military service is obligatory the data show that increasing numbers of persons, who, on account of age, are amenable to military service, are found unfit in conditions of peace to perform the duties of the soldier even in time of peace. The recruiting officers of France and Germany, of England and of Italy, as well as of other nations, have been struck with the growing percentage of persons who, when the proper age is attained, are unfit for the camp. This condition has excited grave alarm among statesmen

and rulers, not alone because of the threat to the individual, but by reason of the supposed threat to the state. If the citizens of a country are not capable of bearing arms and performing, in military life, the duties which are so unfortunately and yet so commonly required, it is time to consider seriously the threatened welfare of the nation.

In all cases where special studies of the causes of this degeneracy have been instituted one fundamental condition has been disclosed; namely, insufficiency of diet, especially in infancy and childhood. There are many other causes of degeneracy which have been pointed out. Among these the use of alcohol and similar drugs occupies a prominent position. The unfortunate conditions which come from the herding of large masses of men in cities predisposes to the creation and invigoration of the factors which threaten the physical welfare of the nation. The use of alcohol, tobacco, and other stimulants seems to be a natural sequence of crowding. These matters, bad as they are, might be tolerated were it not that all such indulgences in the way of expensive articles which do not nourish limit the funds which can be expended for real food. Many students of eco-

nomical and sanitary conditions are convinced that the principal cause of degeneracy, after all, is an imperfect diet.

EFFECT OF EXCESS OF CARBOHYDRATES

An analysis of the diet in the conditions described, in so far as I have been able to discover, always shows a wide nutritive ratio. In other words, the proportion of protein, to the fat multiplied by $2\frac{1}{4}$, plus the percentage of carbohydrates, is very small. The quotient, arising from dividing the percentage of fats multiplied by $2\frac{1}{4}$, plus the percentage of carbohydrates, by the protein, in other words, is large. This quotient may rise even to 9 or more in extreme cases. It is the part of wisdom to study the general effect of this low protein diet continued with large numbers of people over long periods of time, as an index of what may happen if the protein part of the food is diminished much below the normal. Attention has been directed already to certain diet diseases which depend largely upon an excess of carbohydrate in the food. While in some cases the proof is not entirely consistent, it is strong enough to convince us almost beyond a reasonable doubt

that there is a serious danger to humanity in a long-continued low protein diet.

DIET DISEASES

Among the principal diseases which seem to arise as a result of this diet may be mentioned scurvy, beri-beri, and pellagra. I do not think that anyone claims for a moment that there is any specific cause necessarily inherent in the low protein diet which produces these diseases. The case seems to be that in a condition of this kind the body is so under-nourished as to invite the entrance of these diseases. The general effect of malnutrition due to lack of protein is to weaken the resistance of the body. All forms of contagious and infectious disease are more to be feared in a weakened condition of the body than in a state of health. The particular forms of the diseases mentioned above are not of general distribution. For instance, in the ordinary community in the United States, even in New York City and other large centers, there is very little scurvy, beri-beri, or pellagra. Scurvy seems to be a diet disease closely related to the exclusion of fresh foods and the consumption of preserved foods, rather than to a low protein diet. Scurvy

may follow the consumption of foods rich in protein, such as preserved meats. On the other hand, beri-beri and pellagra are more typical low protein diseases.

The mass effect produced upon the community must not be looked for in the development of nutritional diseases so much as in the general lowering of the vitality of the body. This leads to a stunted growth in infancy and childhood, so that the individual when he becomes mature is no longer able to bear arms; in other words, no longer able to perform the proper functions of a citizen. It seems to me that it can hardly be denied that the great weight of testimony derived from studies of this description is opposed to a very low protein diet. I do not minimize the other causes, which are associated with a low protein diet in the conditions mentioned, which are deleterious. The crowding of too many people in a room, the insanitary conditions which surround poverty, the degeneracy which comes from sex diseases, the woful effects of alcohol, tobacco, and other drugs upon the vitality, are all combined with a low protein diet in producing the unfortunate conditions which I have endeavored to set forth.

THE EFFECTS OF OVER-FEEDING

Let us turn now for a moment to the other side of the question. In doing this we come upon an entirely different class of people. We are now considering those that are well-to-do, or even rich. We have before us people who not only have plenty to eat, but also who are able to select that which is most pleasing to the taste or most desirable in other ways, irrespective of its cost. What are some of the prevailing diseases which we find among people of this description, and what is the character of the food which they consume? The latter question perhaps should be answered first. A study of the dietaries of the well-to-do and the rich reveals a narrow nutritive ratio; in other words, the percentage of protein, divided into the sum of the percentages of fat multiplied by 2.25 plus the percentage of carbohydrates, is narrow. In other words, the quotient is a small figure, falling sometimes even to 4 or below. We thus have sharply and widely contrasted conditions of life.

DISEASES OF OVER-FEEDING

What are the effects of a long consumption of a diet of this description? The nutritional dis-

eases which we encounter here are gout, hardening of the arteries, albuminuria (Bright's disease), and glycosuria (diabetes). I do not wish for a moment to say that diseases of this kind are not found in the first class discussed, but I think it will be admitted by those who have access to the data that the diseases last named are peculiarly found among the well-fed, or may I say over-fed, parts of humanity. As in the other case, I do not claim that a rich protein diet is specifically causative of the diseases mentioned. As is the case with the low protein diet, this rich protein diet appears to produce a condition of over-nutrition which invites the invasion and support of the nutritional diseases mentioned. It seems to me that there is no doubt, from a careful study of all the data in the case, that the evils of over-protein-feeding are in some respects quite as formidable as those of under-feeding. Fortunately, in the diet of children the effect of over-feeding is not so well marked. The result is that the children of the well-to-do or of the rich are apt to be better nourished, to grow more to normal size, and to enter the race of life better equipped physically than the children of those who are surrounded by excessive poverty. I would not for a moment con-

done the over-feeding of children. But it is the habit of over-eating after mature life which produces the havoc which I have noted. In a choice between two evils I think most of us would prefer to die from over-nutrition. But why should we choose one of these evils? If we could drop off from the diet of the well-to-do the excess of protein and fat which they consume and add it to the diet of those who live in poverty and squalor, we would strike a happy medium which would be of infinite benefit to both classes of our citizens. Specifically, I am of the opinion that the protein content of the food of the average man of a hundred and fifty pounds should not fall below 80 grams per day, and perhaps would be better at from 90 to 100 grams per day. Compare this with the enforced diet of the poor, which often falls to 60, 50, or even 40, grams of protein per day, and the contrast between the two classes of the community is more highly accentuated.

SOURCES OF PROTEIN

As to the sources of this protein, I have already called attention to the fact that for the infant it should be exclusively from milk, and in the child from milk and cereals principally. For the grown

person, not excluding these sources, it may be derived largely from fresh or properly preserved animal diet other than milk or eggs. From an economic point of view, the protein should be derived from those foods which cost the least, and among these no complete nourishing foods can rank with the cereals in cheapness. Wheat at a dollar a bushel is the most economic food a man can eat. It contains a generous portion of protein, about 14 per cent. on its dry weight. A simple calculation will show the nutritive ratio of a diet composed exclusively of whole wheat. In this diet there are 14 pounds of protein, 2 pounds of fat, 80 pounds of carbohydrates, and 4 pounds of ash and unnamed ingredients per hundred. Multiplying the fat by $2\frac{1}{4}$, adding the percentage of carbohydrates, and dividing by the percentage of protein, we have in round numbers a quotient of 6, which is an ideal nutritive ratio. When foods richer in carbohydrates are consumed, as is the case with rice, white flour, fruits, and vegetables, a protein diet which is richer than that of wheat should be taken to balance the ration. This may be found in the legumes (peas and beans) and in lean meats. These sources of foods, however, are much more expensive, and hence as the basic

diet I have always insisted upon whole cereals as the foundation on which the whole menu is to be built.

I am convinced, from a careful study of the conditions of nutrition which obtain in poverty-stricken localities, that a large percentage of the suffering for food is due to ignorance of the fundamental principles of nutrition. The organized official and non-official and private charities whose purse strings are loosed at the cry of distress would minister far more efficiently to the wants of the hungry if they could take a primer of the fundamental principles of nutrition in one hand and their basket of provisions in the other. I think I do not overestimate this point when I state that from twenty-five to thirty-five per cent. of the suffering from under-nutrition could be removed without expending a single cent more for food by spending it for the proper foods. The misguided charity which gives tea and coffee and puddings and pies and cakes and candy to communities suffering from under-nutrition is laudable from the philanthropic point of view, but extremely undesirable from the nutritional point of view.

In so far as the nutrition of the infant is concerned, this ratio of protein to the other food

constituents does not hold. In fact, in mother's milk the number expressing the ratio may rise as high as 10. At the weaning period the ratio rapidly diminishes, so that by the time the infant becomes the child of two years it is almost the same as for the adult. Poverty, therefore, works its most frightful results among the growing children of the suffering communities. If we could be well nourished until we were full grown, we could tolerate the conditions which exist in poverty-stricken localities with far less discomfort and disaster than we do at the present time. A child who has had the proper food will be fit to serve his country in the army and to make forced marches and do good fighting on a low diet; and this he can never do if the under-nourishment begins in childhood. I do not wish to convey the idea that war is the sole industry. I only illustrate the case by citing fitness to bear arms as a fundamental state of physical fitness which every citizen should attain, whether called upon to bear arms or not.

WHOLESOMENESS OF ANIMAL FOOD

The question of the wholesomeness of animal foods for the human animal is eternal. It probably will never be answered in a manner to

silence discussion. There is no great need that it should be. The thing most desirable is that the consensus of expert opinion should be interpreted in such a way as to protect to the utmost degree the health of the eater. Strong as the reasons are in favor of a vegetable diet, they break down under the force of experience and comparative anatomy. For instance, one reason which has been urged in favor of a vegetable diet is that carbohydrates form the chief part of human food measured by weight or volume. On the contrary, in ordinary meat products the amount of carbohydrate present is exceedingly small, comprising only the glycogen (generator of sugar) which the meat may contain. This rarely exceeds $1\frac{1}{2}$ per cent., and unless meats are used soon after slaughter usually falls to almost undetectable quantities.

This argument had considerable force, the force of analogy, until recent discoveries in the realm of nutrition disclosed the fact that a large part of the protein ingested as human food is converted into carbohydrate by the nutritional processes, and this carbohydrate, in so far as our knowledge extends, is quite as useful in the nourishment of the body as if it existed primarily in

the food. Thus the apparent difficulty of reconciling the health of meat-eating animals, consuming practically no carbohydrate, with the well-known principle that animal foods consist chiefly of carbohydrates, has been cleared away. Even meat-eating animals have a generous portion of carbohydrates, due to the conversion of a large part of the non-nitrogenous protein molecule into sugar. The cutting the carbohydrates off completely from human food, as is often attempted in cases of diabetes, does not succeed in furnishing a nutriment devoid of sugars if, as is always the case, the nitrogenous elements of the foods are maintained, or even increased, when the carbohydrate supplies are shut off. Of special importance in this case, in view of the confusing directions which are given for the nourishment of infants and young children, is the problem of the meat element of their nutrition.

LESSON V

CARBOHYDRATES

UNDER this term are included all foods built upon the type of starch and sugar.

There are as many different kinds of starches as there are plants that produce them. On the contrary, the number of sugars used for food purposes is somewhat limited. In addition to starch and sugar, there are certain celluloses which are slightly digestible in the human intestine, and also are largely digested in the stomachs of ruminant animals.

FUNCTION OF CARBOHYDRATES

The function of carbohydrates in nutrition is apparently the simplest and yet in many respects the most complicated of the problems that underlie growth and other vital processes. We are content, as a rule, to look at carbohydrates solely from the energy or heat point of view. If the human body develops a certain degree of heat, it must have fuel, and carbohydrate is one of those fuels.

This point of view is of the greatest importance, yet it by no means covers the whole ground. In fact, it is quite impracticable to select any single element of foods and treat it independently of its relations to foods in general.

The energy value of the carbohydrate is easily ascertained by burning the carbohydrate in a calorimeter. The quantity of heat produced when the combustion is properly conducted and controlled is easily and accurately measured. We may, therefore, infer that all of the carbohydrates ingested in a state of health are sooner or later burned and their energy thus liberated as heat in the human body.

In this process, however, many other functions are performed, chief of which is that the carbohydrate saves the rest of the ration in order that the general vital functions may be conducted without disturbance. From a food point of view, before considering the carbohydrates in detail, it is well to understand that they exist in two forms. In one form, such as soluble sugars, they are ready at once to submit themselves to the action of the digestive ferments. When the carbohydrates, on the other hand, are insoluble, that is, consisting of starches and cellulose (woody fiber),

they are of no value for food purposes until they are first changed into soluble materials. These changes are produced by the action of enzymes, which attack, on the one hand, starch, and, on the other, cellulose, and convert each of them into sugar (maltose, dextrose), which is soluble in water. The enzyme which liquefies the starch (ptyalin, amylase) is of a different species from that which dissolves the cellulose (cytase).

SUITABILITY OF DIGESTIVE ORGANS

The character of the digestive apparatus is, also, very different in meat-eating and vegetable-eating animals. In animals that live wholly upon vegetables the digestive organs are much more complicated and have a much greater burden to perform than in those that eat solely animal products. Animals, such as man, that occupy an intermediate position between the meat-eaters, on the one hand, and vegetable-eaters, on the other, have a digestive apparatus which anatomically and functionally stands midway between the other two classes of animals. In the vegetable-eating animals, those that eat coarse fibers, such as hay, fodder, and grass, containing large quantities of cellulose, secrete in great abundance digestive fer-

ments (cytase) that act upon these bodies. For illustration, if a meat-eating animal could chew hay, he would digest practically none of it. If a horse should chew hay, he would digest the greater part of it. If a man should eat hay, chewing it very finely, he would digest a small part of it. In so far as the digestion of cellulose is concerned, one of the most important of the carbohydrates in the nutrition of ruminant animals, the digestive system of man is much nearer that of the meat-eating animal than it is that of the vegetable-eating animal.

This fact is an important one from the point of view of the mixed diet, but is not so strongly directive as to warrant the conclusion that the diet of man should be mostly animal. In point of fact, the vegetables that man eats contain as a rule only minimum quantities of cellulose, and hence man does not need the multiple stomachs nor the highly active cellulose solvents which are required for ruminant animals. The importance of a proper quantity of carbohydrates is indicated especially in disorders of digestion. There are many diseases, as, for instance, diabetes, in which theoretically carbohydrates should be as far as possible excluded, and yet in practice it is found

that such an entire exclusion might work serious injury. Again, in that disordered condition of the human body which is known as acidosis—in other words, when the acids in the body are dominant over the bases—it is not only a mark of good treatment to increase the quantity of basic materials in the food, but also it is found that a proper increase in the amount of carbohydrates may do much towards remedying the disturbed condition of the digestive organs. Carbohydrates are not, therefore, valuable solely because they constitute the greater part of the food of the human body, but with equal reason because they regulate, dominate, and control, to a large extent, the normal nutritional processes.

STARCHES

The starches differ from one another chiefly in physical structure and in their ability to resist the action of digestive ferments. All starches in their pure state look alike to the eye, but each one reveals a peculiar structure under the microscope. We may assume that all the principal starches used for food differ little in digestive properties, and that their physical differences, which consist chiefly in the size of the granules and in their

shape, are of little consequence. Among the common starches in which the granules are large, that of the potato is the most important. Its granules are oval in shape, containing no sharp angles, and are marked with a cross when viewed with polarized light. Among the smallest of the starch granules are those of Indian corn (maize), which, though small and of angular shape, are also marked with a definite cross under polarized light. Wheat starch resembles potato in shape, but the granules are very much smaller. Only the expert microscopist is able to distinguish with certainty many of the varieties of starch.

All starches have one common chemical property. If a granule of starch is boiled with a little water so as to make a thin paste, cooled, and treated with a drop of dilute solution of iodine, an intensely blue color is produced. The starches form the principal bulk of carbohydrate foods. From 60 to 70 per cent. of the wheat grain, from 65 to 75 per cent. of the grain of Indian corn, and from 70 to 80 per cent. of the grains of rice, consist of starch. All cereal grains are composed chiefly of starch. Among the vegetables, the potato is the representative starch-producer, having a little over 20 per cent. of solid matter, of which approxi-

mately 18 per cent. consists of starch. Considerable amounts of starch are found also in peas and beans, in carrots and radishes, and in many other foods. In fact, there is scarcely any of the vegetable foods which does not contain a notable percentage of this substance. The artichoke, the variety which yields edible tubers, contains a large percentage of a carbohydrate known as inulin, which is similar to starch in its nutritive value, but of quite a different character chemically. The percentage of inulin in the artichoke is about the same as the percentage of starch in the potato.

SUGARS

Closely allied to starch from a nutritive point of view, but quite different in physical and chemical qualities, is sugar, which, next to starch, is the most important of the carbohydrate foods. The term "sugar," when used without qualification, indicates the ordinary sugar used upon the table. This particular kind of sugar is known to the chemist as sucrose, or cane-sugar. It is found universally in plant life, and represents probably the first product of growth. The physiologists have shown that sugars are produced under the influence of chlorophyl, the green coloring-matter

of the leaf, by combining with water the carbon dioxid which exists in the air and the soil. Subsequently this sugar is translated to various parts of the plant, where it is either stored as sugar or converted into starch or cellulose (woody fiber). Sugar, therefore, may be regarded as the dominant factor of plant life, although cereals have only a small quantity of it, varying from 1 to 3 per cent.

The sugar-cane and the sugar-beet are the chief sources of commercial sugar, although small quantities are made commercially from the sap of the maple and the sap of the sugar-palm. The citizens of the United States annually consume about eighty pounds per head of commercial sugar. This does not include a large quantity which is consumed in ordinary foods. It would be safe to say that the average citizen of the United States uses up, in some form or other, nearly one-quarter of a pound of sugar per day. This is not all consumed directly, but in the form of special kinds of foods, such as preserves, jellies, jams, confectionery, cakes, etc. With sugar at five cents a pound, each individual in the United States would spend about four dollars for commercial sugar per year, making the annual charge for this pur-

pose to the people of the United States something near four hundred millions of dollars.

Besides its pleasant taste, sugar has all the food-value of starch, while it is more readily prepared for assimilation than starch because of its natural solubility in water. Sugar, however, is not used as such by the tissues. Before becoming available for fuel in the body, or for fat-building purposes, it is resolved into two related forms, which are known in common language as dextrose and levulose. These terms indicate that when these sugars are submitted to examination by polarized light, the dextrose turns the plane of polarization to the right and the levulose to the left. In a state of health these two sugars are assimilated and burned with equal facility. In certain disorders of health, as, for instance, those which induce diabetes, the dextrose is less readily burned, and by reason of escaping the process of combustion, is excreted in the urine. Even in these cases, however, the levulose is either burned in the tissues of the body or converted by some biological process into dextrose, so that levulose is rarely found as a urinary excretion.

FOODS RICH IN SUGAR

Among the natural foods which contain notable quantities of sugar may be mentioned the following: beets, sweet potatoes, turnips, radishes, carrots, and other root crops. Indeed, all the common vegetable foods consumed by man contain notable quantities of sugar. The sugar-beet yields from 10 to 18 per cent., and the sweet potato has from 4 to 7 per cent. The natural food richest in sugar content, however, is honey. Nearly all the solid content of honey is composed of sugars; namely, levulose and dextrose in practically equal proportions, in which are usually mixed small quantities of ordinary sugar. Honey is the type of natural sugar foods. Prepared foods which are largely sugars include, besides the ordinary sugar of commerce, molasses, syrups of all kinds, and confections. Among the confections are included the sugar cakes of various kinds, which are such a common component of desserts, and candies of every description.

NUTRITIVE PROPERTIES

The carbohydrates, constituting as they do practically two-thirds of all human foods, are of special interest in all studies of nutrition. The

principal function of the carbohydrates is the production of heat and energy. They are burned in the tissues of the body, in the normal functioning thereof, to carbon dioxid and water. These products are largely removed from the body through the lungs, and, in so far as the water is concerned, to a large extent through the skin and kidneys. In the process of respiration, the air containing pure oxygen is introduced into the blood through the lungs. In the capillary tissues of the body the oxygen which is carried into the blood burns, among other things, the carbohydrates, and the carbon dioxid and water produced are carried away by the veins and returned to the lungs for elimination. The greater part of the heat and energy of the human body is, therefore, due to the combustion of carbohydrates.

The carbohydrates also take part in tissue-building. Especially is it believed by physiologists that a considerable part of the fatty tissues of the body are synthesized to a certain extent from the carbohydrates of the food. While biologic change is difficult to demonstrate, the above fact has been accepted as a rule by the physiologists for a number of years. The carbohydrates have also a third function. They modify pro-

foundly the processes of assimilation of other foods, especially of proteins, and play a most important rôle in the general economy of life. They also spare the consumption of the nitrogenous tissues of the body.

PRELIMINARY CHANGES

All the carbohydrates ingested with the food undergo certain preliminary changes in the digestive tract. In the first place, the sugar is changed into dextrose and levulose, or, to use a common expression, it is inverted. This change takes place under the action of certain sugar-splitting enzymes, which are allied in character to those that attack starch. By reason of its high degree of solubility, sugar rapidly enters the circulation when taken into the stomach. It is, therefore, a food product which gives almost immediately the raw materials necessary to the living processes. A person who is suffering from physical fatigue receives a very prompt supply of energy from the eating of sugar. Heavy physical burdens may be carried and great work performed for a limited time from the strength and energy derived from the consumption of large quantities of this food product.

Starches which are insoluble in water undergo a more profound change. This change commences at the very beginning of digestion; namely, during the process of mastication. The saliva contains an enzyme known as ptyalin, which has the property of acting upon starch, making it soluble and converting it into maltose and dextrin. When the food is swallowed, the acidity of the stomach juices hinders after a time the action of the starch-splitting enzyme, which does not give its maximum activity except in a faintly acid solution. When stomach digestion is completed and the food enters the small intestine, it meets with alkaline media, and the enzymes secreted, especially by the pancreas, rapidly complete the resolution of the starch into soluble products suitable for assimilation. From this it is seen that the process of carbohydrate digestion, in the ordinary sense of that term, begins in the mouth, is hindered or suspended to some extent in the stomach, and regains its activity in the small intestine.

QUANTITIES OF CARBOHYDRATES

The amount of carbohydrate required as a food is regulated to a certain extent by the quantity of fat which the food contains. As the quantity of

fat increases, the necessity for large quantities of carbohydrates diminishes. In other words, carbohydrates and fats are to a certain extent complementary in the nutritive process. Assuming that the daily dietary should contain three thousand Calories, it is evident that over half of this amount will be derived, as a rule, from carbohydrates.

Of the ordinary foods the carbohydrates have the minimum heat-producing power, less than half that possessed by an equal weight of fat. If complete combustion is secured, the carbohydrates are also distinctly inferior in heat-producing properties to the proteins, in the proportion of about 4 to $5\frac{1}{2}$. As has already been said, however, the proteins are not completely burned in the process of nutrition, and hence the carbohydrates and the proteins are about equal in respect of the amount of heat which they yield to the human body. A kilogram of carbohydrate will yield 4,000 Calories (round).

The ordinary individual does not require a kilogram of dry food per day, but about 600 grams. Of this quantity, as a rule, about 425 grams will be carbohydrates. In other words, about one pound of dry carbohydrates per day

and approximately one-half pound of dry protein and fat will make the ordinary diet of an individual weighing 150 pounds. It is thus seen that in regard to quantity of food carbohydrate is the leading factor in nutrition.

LESSON VI

FATS AND OILS

THE third principal division of foods includes fats and oils. The common distinction which is made between them is not a very sharp one. In general it may be said that a fatty material that is liquid at ordinary temperatures is an oil, and an oily material that is solid at ordinary temperatures is a fat. Another classification, which is also to a certain extent indefinite, is that fats are of animal origin and oils of vegetable origin; but it must not be forgotten that the whale produces a large amount of oil and that there are certain vegetable fats. Ordinary temperatures mean those of the living-room, which usually do not fall below 60 and rarely rise above blood-heat (about $98\frac{1}{2}$ degrees Fahrenheit).

An important distinction in composition is to be noted between the sugars and starches, representing the carbohydrates, and the fats and oils, representing the third class of food products. In the

QUANTITIES OF FATS AND OILS IN SOME OF THE PRINCIPAL FOODS ¹

Almonds	54 per cent.
Barley	2.2 " "
Beans (dried)	1.8 " "
Buckwheat	1.2 " "
Cheese	33 " "
Chestnuts	5.4 " "
Chocolate	48 " "
Cocoa	28 " "
Cocoanut	50 " "
Dates	2.8 " "
Indian Cornmeal (whole)	4.7 " "
Oatmeal	7.2 " "
Olives	20 " "
Peanuts	38 " "
Peas (dried)	1 " "
Pecans	70 " "
Pine Nuts	60 " "
Potatoes	0.1 " "
Rice	0.3 " "
Rye Meal	2 " "
Spinach	0.3 " "
Sweet Potatoes	0.6 " "
Tomatoes	0.4 " "
Walnuts	64 " "
Wheat	1.7 " "
Wheat Flour	1 " "

Among the concentrated foods which are offered for consumption, the vegetable oils, lard, tallow, suet, etc., are practically pure fats or oils. Butter contains 82.5 per cent. of fatty substance, the rest being water, 12 to 15 per cent., curd, 1 to 2 per cent., and salt, from none to 3 per cent.

starches and sugars, the elements hydrogen and oxygen occur in the same proportion as in water,

¹ Compiled from O. E. S. Bulletin 28 Rev., U. S. Dept. of Agr.

whereas in the oils and fats the oxygen exists in only very small quantities. In other words, the sugars and starches may be regarded as partly burned, while the extent of the burning in the fats and oils is extremely slight. For this reason the fats and oils are distinctively heat-formers, furnishing the maximum degree of heat and energy during the processes of combustion in the various tissues of the body. A kilogram (2.2 lbs.) of sugars or starches will furnish 4,000 Calories (units) of energy, while a kilogram of fats or oils will furnish 9,300 units of energy.

CLIMATE AND FAT CONSUMPTION

As a consequence, fats and oils are consumed in increasingly large quantities as the temperature of the environment falls. Near the equator, where the average temperature is but little below that of the blood itself, there is little loss of heat by radiation from the human body, and hence those elements which particularly produce heat are required in minimum quantity. But as we approach the polar limits of human habitation, where the average temperatures of the year are below the freezing-point of water, the radiation of heat from the body is greatly increased, and

the requirement of fat in the food is correspondingly greater. A man living at the equator would suffer severely if he consumed the diet of the Eskimo, while the Eskimo would speedily freeze if he tried to live on the fruits and vegetables of the equator.

On the same principle, the quantity of fats and oils in foods of people living in climates like our own should be very much greater in winter than in summer. Our discomfort during hot weather is largely due to the fact that we are not sufficiently acquainted with the principles of nutrition to change our diet to suit the temperatures. It is every bit as foolish during the hot summer months to eat foods rich in fats or oils as it would be to wear our heavy underclothing and fur coats during the same period.

Fats and oils, as is the case with starches and sugars, are often offered for consumption in a practically pure state. In this they differ from the proteins, which are rarely eaten unmixed with other food products. It should not be forgotten, nevertheless, that nature has mixed the oils and fats in our foods so as to give us a very considerable proportion of them, whether we consume any of them in the pure state or not. Animal foods,

as a rule, contain a very considerable proportion of fat. Certain vegetable foods, such as nuts, are also rich in oil. The cereals represent a class of foods which contain the minimum proportion of oils. In milk we find the fat in larger quantity than the protein, but in a somewhat smaller quantity than the sugar, indicating, doubtless, the natural method of combination for the first years of human existence.

PROPORTION OF FAT IN A NORMAL RATION

The list on page 101, although far from complete, will give a general idea of how fats and oils are distributed in vegetable foods. No definite percentage of fat can be stated for animal foods, because they may be almost free of fat or may contain large quantities of it, depending upon the condition of the animal when slaughtered and how the cut is made.

It is also difficult to give any definite expression of the quantity of fat or oil which enters into the normal ration. Aside from the influence of climate, the taste of the individual, natural or acquired, and the possibility of securing such a ration as the individual craves, are important factors here. Environment and personal choice

have a profound influence, not only on the amount, but on the character and distribution of the food components. There are many persons whose tastes differ from those of the great majority of their fellows. One will be unable to eat butter, another lard, while a third will draw the line at a vegetable oil—and so on, in Jack Sprat style, with every element of diet. In order to determine what is approximately normal, we exclude idiosyncrasies of this kind. In general, it may be said that the total average quantity of fat consumed per day by an individual weighing 150 pounds and living in the temperate zone is about 80 grams, almost a fifth of a pound. While in individuals wide variations from this average are often found, it may be regarded as a good approximation of the usual requirement of a fat or an oil.

The quantity of sugar and starch consumed per day is considerably greater than this. There is reason to believe that, especially during the cold months, it would be a wise dietetic practice if the people of our country would consume a larger quantity of oil and less sugar and starch. In the warm months, when succulent vegetables and fruits are abundant, the fat content of the ration

is somewhat diminished. One reason for suggesting a practice of this kind is that an increased consumption of oils, especially for salad purposes, would tend to secure a freer peristaltic action of the intestines, and in this way remedy the very common state of constipation from which so many suffer.

While the normal average requirement of fats is stated above as 80 grams, it is certain that the people of this country are not getting their full share. Especially in southern Europe is the consumption of oils much larger than in this country. On the contrary, the fact that in the United States the consumption of butter is in excess of that of most other countries tends to counterbalance this. If one desires an increased amount of fat, butter is not the cheapest, though otherwise the best, way in which to secure it. Such substances as olive oil, purified cottonseed oil, peanut oil, and other edible vegetable oils are much simpler in constitution, and also, with the exception of olive oil, much cheaper. Butter is a perfectly wholesome and delicious article of diet when eaten in moderation, but would not be ideal for general uses. However, it should be remembered that butter-fat is something more to the

body than the mere heat and energy that it yields. It has properties that give it peculiar value in promoting growth, as has been shown by recent experiments. Sooner or later small animals fed on fat-free foods fail to grow. Butter is the best fat to restore ability to grow.

Undoubtedly olive oil is the most desirable of all the vegetable oils for table use, but a properly prepared cottonseed or peanut oil, either of which is much cheaper, may be substituted. In fact, those who are not accustomed to discriminating between the fine flavors of oils are usually quite as well satisfied with these cheaper sorts. Many dietitians assert that animal oils are not as wholesome as those of vegetable origin, but there does not appear to be any reliable scientific basis for this statement.

OILS PREFERRED TO FATS

There is one scientific reason which would lead to a preference in favor of the vegetable oils. These oils are in a liquid state at the temperature of the body, and hence would seem to lend themselves more readily to the enzymic action which prepares them for absorption into the blood. I do not recall any scientific demonstrations of this

principle, save the following, but its truth would seem to be self-evident. Results of late experiments by A. von Feger (Experiment Station Record, Vol. XXXII, No. 9, p. 858) show that the higher the melting point and the greater the viscosity the longer the fats remain in the stomach. Emulsified fats leave the stomach more rapidly than those not emulsified. We must admit, nevertheless, that the digestive organs have very little difficulty in disposing of the somewhat solid fats which are taken in the consumption of ordinary meat products.

LESSON VII

THE RÔLE OF MINERAL SUBSTANCES

IN a general way, the plant and the animal are distinguished as regards their nutritional needs by the character of food each requires. We think of the animal as living solely on organic materials, such as flesh, fruits, cereals, vegetables, etc., while we regard the plant growing in the soil as living solely on inorganic material, such as potash, phosphorus, nitrogen, sulphur, oxygen, carbon dioxid, etc. In the main, this assumption is correct, but in detail it is not so. There are many plants, such as mushrooms and other fungi, that live largely on organic materials, and all animals require inorganic constituents in their foods. This requirement of the animal is of a double nature. In the first place, inorganic matter, such as phosphorus and lime, is required for purely nutritional or growth purposes. These two elements nourish particularly the bones of the body, though they are found—especially phosphorus—in all the tissues. Iron

also is an important and perhaps necessary constituent of the blood, and other minerals play various rôles in the animal economy.

In the second place, mineral substances are indispensable to living organisms in securing the movements of the liquids of the body, as, for instance, in the circulation of the blood and lymph. The direct impulse is given by the action of the heart; but the heart would refuse to act if the blood were deprived of its mineral constituents. This is demonstrated in cases of very weak heart action, due to depletion of the mineral constituents of the blood, where the injection of a weak salt solution will stimulate the heart's action, and often tide the patient over a crisis and save life. The slow movements of the lymph are due chiefly to varying mineral content.

HOW MINERALS EXERT FORCE

The pressure produced by separating liquids of different saline content by means of a membrane furnishes another illustration of the utility of mineral substances. If a thin membrane, such as a bladder, be partly filled with a salt solution and then immersed in a vessel of water, the external water will enter through the membrane more rap-

idly than the internal solution will exude; and while a certain amount of salt will pass to the exterior portion of the bladder, the total volume of the liquor therein will increase. If the bladder be furnished with an upright tube, the liquid contents will be forced into the tube, thus showing that a high degree of pressure is exerted under the conditions stated.

The term "osmotic" is given to a force of this kind, and the process of translation of the liquids through the walls of the membrane is called "osmosis." Osmosis plays a most important rôle in animal life, owing to the fact that the quantity of saline constituents in the different liquids of the body is variable. Mineral matters that are concerned in osmotic pressure need not necessarily undergo any change in the body. A very large proportion of the common salt which is ingested in the food is secreted unchanged in the urine. On the other hand, mineral matters may undergo digestive processes; in other words, suffer changes of a radical character. Common salt in the body may be, and is to a certain degree, separated—the chlorin, which is one of its constituents, appearing as hydrochloric acid, especially in the stomach, and the sodium, which is its other

constituent, appearing in combination with the carbon dioxid in the blood-stream, serving to maintain its alkalinity. Sulphur and phosphorus in foods are largely transformed in the process of nutrition.

SAVE THE MINERALS

It is easy to see, therefore, how profound a rôle mineral substances play in animal economy, and how the very common habit of minimizing their use in foods is founded on error. It is true that, as with all good things, the use of them may be abused. This is often the result of a somewhat vitiated taste, as where one acquires a liking for an excessive amount of common salt. On the other hand, it may be due to errors in the preparation of food, such as the introduction into bread of very large quantities of mineral matters in the form of baking powders.

There is a well-known mineral hunger which is normal, not only in plants, but in animals; and that course of diet is not based on sound physiological principles which denies to man the normal amount of mineral substances. As a rule, with the possible exception of common salt, all the mineral substances necessary for human nutrition

are found in pure and wholesome foods. By reason of the refinements, or progress, or whatever you please to call it, of modern cookery, the greater part of the natural mineral substances in some important human foods has been eliminated, little by little. Nature has placed the larger amount of minerals in foods chiefly on their exterior coverings. In the skins of the potato, the apple, the peach, and other fruits, and in the bran of cereals, is found the greatest quantity of the mineral substances in these products. The complete removal of these coverings influences in a very unfavorable way the wholesomeness of the food. Especially for the growing child should care be exercised to secure foods in the form which retains these essential ingredients. It is a great dietetic mistake to feed young children, when they are able to chew thoroughly, exclusively on white flour, peeled fruits, and other foods from which the chief part of the mineral substances has been removed.

PHOSPHORUS AND LIME

The two most important mineral foods, from the point of view of growth, are phosphorus and lime. The phosphorus in foods exists largely in

two forms. First, there is organic phosphorus, which is found in large quantities in the yolk of eggs and in the germs of cereals. In these cases the phosphorus exists very largely in the form of compounds known as lecithin and nuclein, which apparently is the ideal source of phosphorus for nutritive purposes, although, as combined in these bodies, phosphorus is hardly to be considered a mineral, because it exists in organic combination. While it is true, doubtless, that pure, inorganic phosphorus in the form of mineral salts may be assimilated, there is little doubt that its most favorable form for nutritive purposes is in an organic combination of the kind mentioned.

The phosphorus which enters the body has a double fate. That part of it necessary for restoring waste and building new tissues is abstracted from the blood-stream and assimilated by the tissues to which it belongs. Any excess of phosphorus in the food would be excreted chiefly through the feces. In the second place, the phosphorus which has performed its function in the human economy is forced back into the blood-stream, and separated therefrom chiefly by the kidneys, and appears in the urine. In a person of average weight, living on a normal diet, the

daily requirements of phosphates are from three to five grams (45 to 75 grains). This quantity of phosphorus is found in the normal diet, provided the latter has not been depleted of its mineral content in its passage through the mill and the kitchen.

Another important mineral constituent is lime. Lime is carried in all whole foods of a vegetable origin, and is also a universal constituent of drinking waters—other than rain or distilled. Lime is one of the most valuable constituents of milk, being combined chiefly with citric acid (the acid of citrous fruits). As has already been stated, one of the chief functions of lime is in the structure of the teeth and the osseous portions of the skeleton. It is universally distributed in small quantities in the other tissues of the body. In this particular respect the animal and the plant are closely allied in regard to their nutritional wants, both requiring abundant quantities of lime and phosphorus. Sulphur is another very important mineral nutrient, but apparently it is utilized solely in organic combination. About 1 per cent. of proteins consists of sulphur, and this is supplied abundantly in both vegetable and animal forms. The sulphuric acid which plays such

an important part in the excretion of the end products of protein metabolism comes chiefly from the sulphur in protein foods.

SODA AND POTASH

The alkalis, in the form of the salts of soda and the salts of potash, seem to take a leading part in tissue life. Potash especially is an important constituent of the protoplasm and soda of the circulating fluids. Sodium compounds are especially valuable, in the form of carbonates, in contributing to the maintenance of the alkalinity of the blood, which is a condition necessary to health. There is always a threat of grave danger when the alkalinity of the blood falls below the normal; indeed, if it falls too far below, the condition of acidosis, which is a grave threat to both health and life, is established. The salts of the alkalis apparently are those most fundamentally concerned in the production of osmotic pressure.

Iron is one of the mineral elements of the blood which has a peculiar function, acknowledged by most physiologists, in relation to the oxidations which take place in the body. Iron compounds are well known as carriers of oxygen, and physiologists generally maintain that iron is one of the

materials indispensable to the correct functioning of all the organs. In addition to these mineral substances of superior importance, it is probable that magnesia and other elements exist in small traces normally, and contribute in a measure to the osmotic conditions which are necessary to life and health. Iodin also is found in, and is thought to have an important function in connection with the thyroid gland.

Other mineral substances are found as accidental constituents of the body, such as fluorin and arsenic, but these can hardly be considered as essential constituents of the tissues of the human body.

It should not be forgotten that the physiological balance of mineral constituents is of the utmost importance. It is a wonderful adaptability of nature and an exhibition of the highest possible chemical skill which maintains, in health, so unfailingly an acid condition of the stomach and an alkaline condition of the small intestines and of the blood. If this balance should be disturbed even for a short period, if the stomach should become alkaline and the blood slightly acid, life could not long be maintained.

FOODS PROVIDING MINERALS

Many of our correspondents ask what foods should be eaten to provide mineral ingredients. Although the latter are scattered in small amounts throughout almost the entire dietary, some foods contain larger amounts than others, and the accompanying list, from Dr. M. S. Rose's "Laboratory Hand Book for Dietetics," gives the foods that contain notable amounts of the three most important minerals; namely, calcium or lime, phosphorus (P_2O_5), and iron.

The idea that you can feed your brain, or teeth, or bones with a special diet is a mistaken one, but it is most essential to the growing child, who is forming bones and teeth at a rate never to be equaled in later life, that its ration should not be lacking in these mineral salts, especially calcium and phosphorus. The mere fact that a little larger amount of these ingredients exists in one food than in another, does not necessarily indicate superiority. The element may be present in smaller amounts, but in a more available form, or the food which contains the smaller amount may be eaten in larger quantities. There is great danger of distorting and misapplying dietary

figures of this kind, and they should all be used with a grain of common sense, and with a broad view of the subject.

TABLE SHOWING PERCENTAGES OF CALCIUM, PHOSPHORUS, AND IRON IN COMMON FOODS

Food	LIME (CaO) (Needed by bones and teeth)	PHOSPHORIC ACID (P ₂ O ₅) (Essen- tial to cell life and to the bones)	IRON (Essen- tial ele- ment of the blood and of cell nuclei)
	Per cent.	Per cent.	Per cent.
1 Cheese	1.10	1.45	..
2 Almonds	.30	.87	.002
3 Cottage cheese	.30	.50	..
4 Beans (dried)	.22	1.14	.007
5 Egg-yolk	.2	1.0	.0085
6 Milk	.168	.215	.00024
7 Wheat-bran	.14	3.0	..
8 Chocolate	.14	.90	..
9 Oatmeal	.13	.872	.0036
10 Lentils	.12	.66	.0086
11 Peanuts	.10	.90	.002
12 Spinach	.09	.13	.0032
13 Turnips	.089	.117	.0005
14 Raisins	.08	.29	.005
15 Carrots	.077	.10	.0008
16 Rye	.07	.81	.004
17 Whole wheat	.061	.902	.0053
18 Prunes	.06	.25	.0029
19 Salmon	.011	.42	.0015
20 Lean beef	.011	.50	.0038

LESSON VIII

HOW THE FUEL AND BUILDING MATERIALS OF THE BODY ARE PREPARED

HAVING briefly described the principal classes of foods, we now come to the more particular study of the process of nutrition itself. It is well to have a clear understanding of terms, in order that no confusion may arise. The term "digestion" is commonly employed to mean the preparation of the food for absorption into the blood-stream from the alimentary organs. In this sense digestion consists of the following steps:

If the food is not liquid or already in a finely divided state, the first step in digestion is a mechanical one, and consists of mastication. The mastication of food has a double purpose. In the first place, mechanically it reduces the solid particles of food to a more or less impalpable pulp. At the same time mastication favors the solution of the starch particles of foods. In the process of digestion the flow of saliva is not only useful

mechanically, in forming a semi-liquid mass of the food preparatory to deglutition, but the saliva also contains a digestive ferment which actively participates in the conversion of starch into a soluble form. This particular ferment in saliva is known as *ptyalin*.

THE DIGESTION OF NITROGENOUS FOODS

When the food reaches the stomach it comes into contact with an acid medium. The principal acid of the stomach is hydrochloric (muriatic), derived probably from the separation of the elements of common salt. This acid is sufficient to neutralize more or less promptly the slightly alkaline saliva, and then temporarily to restrict or inhibit its activity. This retardation is manifested first only on the exterior parts of food, and the starch digestion of the interior of the food may continue an hour or longer after it reaches the stomach.

Stomach digestion is essentially confined to the nitrogenous matters of the food. Most of the nitrogenous foods which we eat are wholly insoluble in the alimentary liquids, and hence must be reduced to a soluble state before incipient digestion is secured and their preparation for absorp-

tion is completed. This digestion of the nitrogenous matters is largely effected by a ferment secreted from glands in the walls of the stomach, particularly at the time of taking food. It is known as pepsin, and its function is to render soluble the nitrogenous elements of foods. Another ferment in the stomach is rennin, the sole purpose of which is to curdle milk. The clotted milk is retained in the stomach until dissolved by the pepsin. In normal conditions of health and with proper mastication and proper quantities of foods, the action of the pepsin goes on rapidly, so that in a few hours after the ingestion of protein food the stomach is practically empty. The starch has already been sufficiently liquefied to pass through with the other liquid or semi-liquid contents of the stomach into the upper end of the small intestines, the duodenum.

DIGESTION IN ITS FINAL STAGES

It is thus seen that when the food passes through the pylorus into the duodenum, it has been partially liquefied, both as to its starch and its nitrogenous elements. Sugars are already liquids, and fats and oils are practically so at the temperature of the stomach. We have thus a

somewhat heterogeneous semi-liquid mass passing into the stages of final digestion. The nitrogenous portions having been thoroughly liquefied or semi-liquefied, enter now, together with the other contents of the stomach, into an alkaline medium, the acidity of the stomach's contents being neutralized either by the absorption of the acid or by a combination with bases supplied by the bile and pancreatic and duodenal juices. In the small intestine, especially in the upper portions of it, the food again comes into contact with another series of digestive enzymes, secreted chiefly by the pancreas. The pancreas, however, not only has the property of secreting enzymes which transform starch into sugar, but it also secretes enzymes which complete the breaking down of the nitrogenous tissues and emulsify and split the fat globules. Thus the food, as it passes through the small intestine, is reduced completely to those forms suitable for passage into the bloodstream. It is claimed by some authorities that the final splitting of the protein molecule into amino acids is accomplished in the membranes of the intestines, or even in the tissues of the body.

The ferments which are active in the digestion of the food belong to three classes. Those that

split starch and sugar are called, from the Latin name of starch, amylases. Those that reduce the nitrogenous tissues to their final form of assimilation are called proteolytic ferments. Those which split the fats are called lipases. The object of digestion is not only to secure a liquid which will pass into the absorbent system and reach the blood-stream, but also to reduce these materials to a form suitable for use in the body. As the purpose of food is to build tissue, restore waste, and supply energy (heat), the digestive process must reduce the food to a proper degree of disintegration to be used for these purposes.

THE ACTION OF ENZYMES

The final form to which foods are disintegrated is not definitely determined, but enough is known to show that the sugar which is ingested is converted into dextrose and levulose, while the starch is changed chiefly into maltose, dextrin, and dextrose. The fats are emulsified and split into glycerin and fatty acids, and the protein materials are reduced to "amino acids." The various amino acids are the fundamental building-stones of all the nitrogenous tissues of the body. When the various forms of food, under the influence of

enzymic action, have been reduced to the proper degree of sub-division, they pass readily through the walls of the intestine and enter the bloodstream on their way to new life and new duties.

In the above review of the fate of the food in the intestines the changing acidity and alkalinity of the digestive secretions has been noted. Important as these changes are, their magnitude is not great. The digestion of all the kinds of foods goes on synchronously in all parts of the alimentary canal. While starch digestion takes place in the very slightly alkaline saliva, recent investigations have shown that an exceedingly faint acidity gives the optimum activity to the starch-splitting ferment. A pronounced acidity, however, checks this action. Thus starch digestion may be temporarily activated when the saliva-starch mixed food first enters the stomach.

LESSON IX

A FURTHER CONSIDERATION OF THE INTRICATE PROCESSES OF DIGESTION

THE process by which the digested food is taken into the blood-stream, built up into the tissues, and finally discarded, is a subject connected directly with nutrition, and a knowledge of it is fundamental in understanding the true function of the nutritive processes. It is by the study of these problems in chemical physiology that we reach a true conception of what the constitution of the food should be in order to afford a proper nourishment of the body.

Already sufficient progress has been made in this direction to show that it is not merely a problem of protein, for instance, in the balancing of the ration, which has to be considered, but also the kind of protein. If the protein does not in its decomposition furnish the right kind of building-stones, it is evident that the building cannot go on. In the same manner it has been found, by recent researches in controlled feeding, that cer-

tain kinds of fat appear to be more useful in the diet than others. This is particularly true with regard to butter fat, which recent investigations show has certain peculiar properties in the promotion of growth which other fats in equal quantity do not seem able to provide.

For the same reasons it may be discovered later on that the starches and sugars also have different relations to nutrition, although theoretically they yield approximately the same quantities of heat and energy. I have long held to the opinion that the sugars which are formed by natural processes—such, for instance, as cane, beet, malt, and milk sugar—are better suited to the nourishment of the body than equal quantities of dextrose or dextrin produced from starch by the action of acids.

The development of these facts, although belonging chiefly to biological chemistry, is shedding great light on the fundamental principles of nutrition. In like manner, the mechanism by which the digested foods reach the blood-stream, and the way in which they are distributed therein, the changes which take place in the liver and in the tissues, looking to the transformation of food materials into tissues of the body, are fundamentally connected with a correct idea of nutritive

processes. In fact, it is quite impossible to draw a close line of demarcation between physiological chemistry and the science of nutrition.

FINAL PREPARATION OF FOODS FOR ABSORPTION

In regard to the absorption of the food from the alimentary canal, attention has already been called to the fact that some parts of the food are absorbed from the stomach. The digestive processes in the stomach, however, are quite incomplete, and hence it is not surprising to find that the principal absorption of the food materials takes place in the small intestine, where the final processes of digestion are completed. In the small intestine the finely comminuted and partially dissolved food products are brought into contact with the elements which complete the digestive processes. They are furnished chiefly by the pancreas, but the activities of certain intestinal glands and secretions from the liver (bile) also take part in the process. All these secretions are mixed with the food soon after its exit from the stomach, and the processes which they induce are carried on simultaneously during the course of the food through the small intestine.

The most important step in the final process of

digestion consists in the completion of the conversion of starch into sugar. The enzyme which produces this action is similar in character to that contained in the saliva, but is much more abundant and active. The final product of this combined enzymic action is a sugar (called dextrose), although it is certain that on the road to dextrose, dextrans and maltose are intermediate products. This final act in the digestion of starch is only a completion of the process of digestion which begins in the mouth.

The oils and fats also are profoundly changed through the action of the bile and pancreatic secretion. The final action on the fats and oils is undoubtedly to break them up into their constituent parts of fatty acids and glycerin. There is also a distinct physical phenomenon connected with this chemical process of separating the fats into their component parts. This physical action is known as emulsification. The fat globules are not chemically decomposed by emulsification, but are separated mechanically into fine particles which no longer coalesce to form distinct droplets. This emulsification is probably promoted by the action of the acid due to the decomposition of the fat. This acid combines with an alkaline base, such as

soda or potash, and forms a soap, and the soap thus formed is an active principle in the further emulsification.

A most interesting fact has been lately discovered in connection with the lipase, the fat-splitting enzyme; namely, that it can not only decompose the fat into an acid and glycerin, but that its action is reversible, so that it may synthesize a fat from these elements. As this enzyme exists in the various tissues of the body to some extent, it is fair to presume that the building of the fat particles of the body may result partly from this action of the lipase, which is capable of re-forming the fats from their separated elements in the blood.

According to some theories, after they are separated and emulsified they are re-combined and enter the circulation as neutral fats, while other physiologists hold to the view that they enter the circulation in the form of glycerin and free acids. Whatever may be the facts in the case, it seems certain that the bile, as well as the pancreatic juice, takes an active part in preparing the fats for absorption and in securing their passage into the blood-stream.

The important fact in relation to nutrition in

this connection is that the kind of fat has a very distinct relation to its absorption. The fats which are fluid—that is, the oils—are more readily digested and absorbed than those whose melting point is above that of blood temperature. Olive oil, for instance, and other edible oils are almost completely absorbed; while fats which partake of the nature of tallow are less completely absorbed. Spermaceti, the fat from the whale, has a very low percentage of absorption. The amount of fat which escapes absorption is largely dependent upon its source and its physical character.

The method by means of which the soluble protein bodies are finally converted into amino acids by the action of the enzymes in the small intestine has already been referred to.

HOW THE FOOD ENTERS THE BLOOD

The next important step in connection with the food, after tracing the changes which it undergoes in order to be suitable to enter the bloodstream, is, How does it find access to the blood so that it may by the blood be carried to all the tissues of the body? We might think that a question of this kind could be answered with perfect definiteness. In other words, it seems reason-

able to suppose that the continuous investigations of the phenomena of digestion by competent experts over so long a period of time would lead to exact data respecting the methods by means of which the dissolved food reaches the circulation. In general, we may say that this is true.

There are three possible methods of absorption of the dissolved foods. In the first place, they may enter the circulation through the venous or arterial capillaries, being absorbed directly into the blood-stream through the walls of the containing vessels. The digestive tract is lined with a mucous membrane which is by no means smooth when observed under the microscope, but is pitted in much the same way as the skin, so that the surface of the mucous membrane is much greater than the superficial area of its inner coat measured in straight lines. Throughout this whole region there is a constant interchange of liquids, principally through the processes of osmosis, so that matters are excreted into the intestine and presumably absorbed from the intestine continuously. This method of food absorption is not of any important magnitude.

The second method of absorption is in its incipency similar to the general method which I

have just described, with this exception, that there is an apparently special system of absorbent cells, each with its small duct leading into others, and thus forming larger vessels, and finally reaching the portal vein, whence the contents absorbed are carried directly to the liver. The scope of absorption which is exercised by the small blood vessels, which, when they unite, form the portal vein, may be said to be as wide as the surface of the intestine itself. The greater part of the blood which returns to the heart from the walls of the intestines is carried first by the portal vein into the liver, and from that organ redistributed to the general circulation.

THE LIVER AND SUGARS

This disposition of the blood is important from the nutritional point of view because of the changes which the liver exerts on the products of absorption. Reference should now be made to the dominant influence of the liver in its care for the soluble carbohydrates which the portal vein carries into the liver in the shape of dextrose or maltose. The question naturally arises, "Since the carbohydrates compose practically two-thirds of the total quantity of food consumed, and since

they are all converted into sugars before they enter the circulation, why is it that the blood when examined for sugar shows so small a content thereof?" The answer to this question is embraced in the statement made above; namely, that the liver converts the sugars into a parent substance (glycogen), which does not enter the circulation, but is stored largely in the liver and tissues, and which may, under the action of certain ferments, generate such additional quantities of sugar as are required by the heat and energy needs of the body. This substance is known as glycogen, that is, a generator of sugar. So vigorous is the action of the liver that when we eat at a meal perhaps as much as half a pound of carbohydrates, all of which enters the circulation within from two to four hours, there is not any quantity of sugar in the blood at any time which is very much greater than that during the intervals between two separate periods of digestive activity. In other words, the quantity of sugar in the blood remains almost constant during the twenty-four hours, though fresh quantities of sugar are not poured into the blood except at the intervals of from two to four hours after a meal.

THE LIVER AND PRODUCTS OF PROTEIN DIGESTION

The next most important function of the liver in caring for the food products carried into it through the portal vein is in its action upon the products of protein digestion. It is now quite generally admitted by experts, following the lead of Folin, that a large proportion of the protein which is ingested in our foods never becomes a part of the living tissues of the body. These products of protein digestion which are not absorbed into the living cell are converted by the liver into two great classes of bodies. In the first place, the radicles of the carbohydrates which are contained in the amino acids, products of protein digestion, are separated completely from the nitrogenous radicles therein and converted by the liver into sugar, and probably stored as glycogen for subsequent use.

The question then arises, What becomes of the nitrogenous radicles? This question also has been answered in an authoritative way by the recent progress in our knowledge of the physiology of nutrition. The nitrogenous radicles are finally reduced to the form of urea, enter the blood-stream, are separated by the kidneys, and

excreted in the urine. Earlier theories of the physiology of nutrition were based upon the assumption that practically all of the nitrogenous elements passed through the cycle of cell life and were there broken down into their end products of urea and other nitrogenous matters. A modern theory has led Folin to recognize two kinds of metabolism of nitrogenous bodies. The nitrogenous bodies which are built into the living cell and pass through the cycle of life and are finally secreted as urea are said to suffer *endogenous* metabolism. Those nitrogenous bodies which enter the liver through the portal vein and are there de-aminized into urea and sugar are said to suffer *exogenous* metabolism.

The question as to which kind of metabolism uses up the greater quantity of our nitrogenous foods has not been definitely answered. One assumption which has long held sway in regard to the rapidity of the change of the living particles of our body suffers a shock of a considerable degree of severity by the adoption of the new theory of the changes which take place in nitrogenous foods. Formerly it was estimated from the total quantity of nitrogen ingested and the total amount excreted that the excreted portions pre-

sumably came from the destruction of living tissues, and there was, therefore, a very rapid change in these tissues. Perhaps this view should now be modified. Not until we are able to ascertain the relative proportions of endogenous and exogenous metabolism of nitrogenous substances can we recast our theories of the duration of any particular particle of nitrogenous material in the living cell. It is evident that the more rapid and thorough the change of the particles of living tissue the greater the expectation of continued youth. The advent of old age, as pointed out by Professor Minot, is associated with the opacity, hardening, and longer detention of the protoplasm. It is reasonable to suppose that the living particle exercises its greatest vital function at the time of its incorporation into the cell tissue, and that this vitality or viability continuously diminishes until the time that the particle is excreted as waste matter. The more completely the cell is composed of new living particles, the younger, therefore, it will be. Possibly the phenomena of old age may be explainable on the ground of retarded metabolism, the particles of tissue matter remaining longer in the tissues as we grow older.

FAT ABSORPTION

The third method of absorption from the intestinal walls is most interesting from the fact that the food particles do not at first enter the blood at all. They are collected by the series of absorbent vessels called the lymphatics, and the liquid which they secrete is known as lymph. The "blood" that flows in the lymphatic vessels is not red, but white, the white color doubtless being due to the absorbed particles of fatty acid in an emulsified form. The lymph appears to be both a nutrient and waste fluid, and its movement is very much slower than that of the blood. The velocity of the blood varies with the diameter of the blood vessel, the quantity of blood passing, and the force of the heartbeat. In the large vessels, like the aorta, the blood is supposed to flow at the rate of at least a foot per second. In the capillaries the flow of the blood is extremely slow. It is quite impracticable, with the facilities now at hand, to make any definite statement as to the exact rapidity of the flow of blood through the capillary. We only know that it is very slow, thus giving time for the transfer of the nutrients which the particle of blood carries and the absorption of the

waste materials which the capillary vein bears away. It is evident that in a stream of this kind the total area of a cross-section of all the vessels at any one part of the complete circulation must be directly related to the speed of flow. The slower the speed, the greater the area of the cross-section. It follows from this that if we could collect into one expression the cross-section areas of all capillaries, it would be immensely greater than the cross-section areas of the blood vessels near the heart.

FORMS OF LYMPH

The lymph exists in two forms: one appears to be the nutrient or protecting fluid which parallels the blood circulation and forms a cushion or bath for the various blood vessels and nutrient cells. The lymph which is absorbed from the intestines we are now particularly considering seems to have quite a different function. As before stated, the white color is doubtless due to the large quantity of fat which the lymph of the intestinal area contains. The lymphatics originate in the little projections which have already been referred to in the walls of the mucous membrane. Each one of the little projections is called a villus. It is

composed of a membrane which is continuous with the lining membrane of the intestine and absorbent cells within this projection, centering in a small duct leading from each villus. Since the liquid contained in these absorbents is of a milk color, the lymphatics which are active in the absorption of food products from the intestine have long been known as lacteals. While the lymphatics have for their chief function the collection of fat, there is no reason to doubt that other kinds of food products also are associated with it.

The lymphatics are gradually collected into a larger vessel, which rises towards the thorax, and is known as the thoracic duct. It ascends to near the top of the thorax, and, curving downward, enters, near the left shoulder, into the subclavian vein. The creamy, smooth mass produced by solution of the food in the stomach and small intestine has long been known by the name of chyme, while the fluid in the thoracic duct, which is made up largely of the fats absorbed from the chyme, has long been known as chyle. The terms are now losing their vogue.

CHIEF METHODS OF ABSORPTION

From the above brief outline of the mechanics of absorption it is evident that the two principal sources by means of which nutrient matter enters the blood are, in the one case, through the portal vein, which carries the great majority of all the soluble products of protein and carbohydrates, and, in the second place, through the thoracic duct, which carries the larger quantity of all the products of the hydrolysis and emulsification of fats and oils. The quantity of food which enters the general circulation without first passing through the portal vein or the thoracic duct must be quite small in comparison with that which enters in the ways described. There is a possibility of small quantities of food entering the circulation through the skin, but this quantity, if any, is undigested and of no practical value.

The question of how much absorption takes place from the coats of the stomach, if any, is one which has been frequently discussed. It is evident that the great majority of the foods we eat is not in a physical state suitable for absorption while in the stomach. Until complete digestion takes place, it is not possible for the

particles of food to enter the pores of the stomach and thus find their way to the circulation. Some forms of ingested articles are found to be rapidly absorbed by the stomach. This is particularly true of alcohol. On the other hand, water, which we would expect to be easily absorbed by the stomach, apparently has a very low factor of absorption. It is demonstrable that certain forms of sugar may pass in small quantities into the circulation through the walls of the stomach. The stomach, however, must be regarded as a laboratory for reducing the foods, chiefly by chemical means, to finer particles rather than as an absorbing medium.

The principal degree of absorption takes place in the small intestine. This is not only a finishing mill in which the particles of food are reduced to the simplest forms, at the same time retaining their liquidity, but it is also the great absorption area from which the food enters the circulation. The large intestine, like the stomach, is not in its essential function an absorbing medium, though there is no question of the fact that absorption takes place to a much greater degree than in the stomach. Water, especially, is absorbed from the large intestine, as is evidenced by the fact that

the feces in normal conditions of health become less and less watery, that is, harder and harder, as they approach the rectum. Food products also are absorbed undoubtedly to a certain extent in the large intestine, and poisonous products of metabolism, especially of protein, are likewise supposed to be absorbed into the circulation from the large intestine. In fact, the indol, phenol, and skatol, which are the three end products of decomposition which are thought to be the most toxic, seem to be absorbed particularly from the large intestine rather than from the small, and in normal conditions are excreted through the urine. As regards the products of bacterial activity, it is evident that they are chiefly absorbed from the large intestine, because the large intestine is the particular home of the innumerable bacteria which seize upon the undigested portions of the food and make an effort to render them soluble by passing them through their own organisms. It is reasonable to suppose that many of these digested products of bacterial activity are perfectly harmless, while others are supposed to be the toxins which tend to induce disease and shorten life.

SELECTIVE ABSORPTION

When it is remembered that the tissues of the body are extremely variable in their composition, it is evident that there is a selective power in their cells to take from the blood-stream those materials which are suitable for their needs. The tissue-building materials may be likened to the bricks or building-stones of a building in course of erection, and each kind of building-material is selected by the tissue peculiar to it. From the blood-stream are separated the materials which build the bony tissue, composed chiefly of phosphate of lime, and the protein tissues of the body of various kinds as they appear in the muscles, the bones, the nerves, and the brain, and in the protective tissues of the body, such as the nails, the skin, and the hair. We must not forget, however, that not all protein bodies have the same ability to maintain life and induce growth. There are certain protein bodies which, if eaten alone, fail to perform the functions that this kind of food is expected to secure. Among the protein bodies which apparently are adapted for complete nutrition are the casein of milk, and to a less degree the glutenin of wheat. On the other hand, such protein bodies as gelatin lack that

ability. Thus the wisdom of a varied diet is illustrated. Inasmuch as the human animal must be nourished whether he understands the laws of nutrition or not, it is a fortunate thing that he has access to various forms of nutritious materials, so that upon the whole no element necessary for his nourishment is lacking.

CHARACTER OF GELATIN

Special attention should be given to gelatin, because it has in many instances been represented as a very sufficient protein diet. At one time these gelatinous principles were recommended very highly as a superior article of food; while at another just the opposite opinion prevailed. There is no doubt of the fact that gelatin is a food product, but it is certain that if it is the only protein substance used, growth and development will be arrested, or may even be started on a retrograde scale. Again, one of the proteins of Indian corn, namely, zein, alone is not sufficient to perform all the functions of a protein diet, but zein becomes a valuable protein when fed in connection with milk.

The average citizen, however, need not bother himself much about the character of the proteins

he consumes, provided he does not neglect any of the natural foods from their varied sources, and does not devote himself to one particular and exclusive form of diet. In order to be safe, I would suggest that any exclusive diet that is adopted be composed largely of one of the established foods, such as milk or wheat, which are found capable of sustaining life.

WHAT MAN DOES NOT KNOW

There is much of mystery, as well as of science, connected with the wonderful processes which go on in the nourishment of the tissues of the body. It is useless to undertake to explain the causes of this selection. We know only that it is operated through fundamentally established laws of physical chemistry which are unalterable and unchangeable. The wonderful syntheses or combinations which are thus produced, forming from this practically inert matter the living tissues in all their varied forms, are of so delicate and complex a nature as to be totally beyond the reach of the most expert chemists. Attempts at the synthesis of organic bodies have been successful outside of the living organism, only in the case of simple substances, such as urea and sugars.

LESSON X

THE KINDS AND QUANTITIES OF FOOD REQUIRED TO KEEP THE BODY RUN- NING SMOOTHLY

IN the practical application of the principles of nutrition it is necessary to understand what is meant by the phrase "a balanced ration." In the building of a house it is quite customary to submit the plans and specifications to a builder or quantity engineer to determine the amounts of the several materials to be used. The owner of the proposed property does not want to buy a lot of material which will not be utilized. The builder does not want to be hampered in his work by running out of any of the materials which he is to use. It is, therefore, the part of economy, as well as of good business, to have all the materials collected in proper proportion, so that nothing will be wanting, and when the building is completed little, if anything, will be left.

The building of the body is in every sense comparable to the building of a house. Certain quan-

tities of the various nutrients are required to do the work. It is highly desirable that these quantities be furnished from day to day in the proportions in which they can be utilized. Thus all the tissue of the body will be properly nourished and no burden of excess will be left for the body to dispose of. In the interest of economy, both in the purchase of food and in the utilization thereof for body-building and heat-forming, it is desirable that the essential elements be present in the proper proportion. That particular arrangement of the diet which enables it to perform all its functions without any large amount of left-over material is called "balancing" the ration. In order that the ration may be properly balanced, due attention must be given to the period of life. The growing child needs, according to its body-weight, more carefully selected materials and a larger amount of them than the grown person; a large man needs proportionately a greater quantity of food than a small one; a man at hard labor needs a much larger quantity of food than the man of sedentary habits. All these factors must be considered in establishing a ration.

NORMAL METABOLISM (SLEEPING)

The scientific standard or basal metabolism is that of an animal at complete rest (sleeping), since in this state the least heat is required.

Generally we begin with the study of a balanced ration for a man of average weight, say, of 150 pounds, engaged in light physical labor, or taking sufficient amount of exercise to represent that labor. These data, properly ascertained, furnish a basis of computation of a balanced diet for those varying from the standard.

For practical purposes it is well to compute the ration upon the average condition of food as respects moisture. While the water in foods is not metabolized in any way, it exercises a very great influence on the processes of digestion, and these processes, on the other hand, produce a great quantity of moisture within the body by the burning of the fats and the carbohydrates, and, to a certain extent, of the proteins.

The average man of 150 pounds engaged at light labor needs one and a half pounds of dry food per day. The term "dry food" does not mean that the food is to be dried, but it means the quantity of food in the day's ration in addi-

tion to the water which it contains. In other words, the human animal at light labor eats 1 per cent. of his weight of dry food per day. The man at hard labor needs a greater quantity. The man who is entirely sedentary in his habits needs a less quantity. The relative amounts of the four principal classes of food in the day's ration of one and a half pounds are approximately: Mineral matters, 2 per cent.; nitrogenous matters (protein), 18.8 per cent.; fats and oils, 15 per cent.; carbohydrates, 64.2 per cent. Converting 24 ounces into quantities representing the above percentages, we have the total amounts of the four classes of nutrients needed in a daily ration expressed in ounces and grams as shown in the second and fourth columns of the following table:

DRY NUTRIENTS FOR 150-POUND MAN PER DAY

Class	Total Ounces	Assimi- lated	Total Grams	Assimi- lated	Calories
Mineral	.5	.4	14.2	10.8	..
Fat	3.6	3.6	102.	102.	949
Protein	4.5	4.1	127.2	114.5	458
Carbohydrates	15.4	13.9	436.3	370.9	1484
					2891

In the above computation are included both the digestible and indigestible portions of the diet.

Practically 90 per cent. of the protein, 85 per cent. of the starches (carbohydrates), and 100 per cent. of the fat and oil are assimilated; that is, they enter the circulation and take part in the functions of food in the body. The residue remains as undissolved matter. This matter, however, is not without utility. While it serves no function as food, it does serve a useful mechanical purpose in securing a proper content of the intestines to secure their normal functioning.

In regard to the mineral matters ingested, practically 75 per cent., including common salt, enters the circulation.

The above is a most generous diet under the conditions specified, being richer in fat and protein than I would as a rule recommend for persons not engaged in vigorous labor or exercise.

It is now quite customary to judge of the value of a ration largely by its heat-forming qualities. The production of animal heat is, of course, one of the important functions of food, and a sufficient amount of food should be eaten to supply the heat (energy) requirements of the body.

A man in the following conditions of activity requires the number of heat units indicated below:

Asleep	65	Calories	per	hour
Awake and at rest.....	100	"	"	"
Engaged in light exercise.....	170	"	"	"
Engaged in active exercise.....	290	"	"	"
Engaged in severe exercise.....	450	"	"	"
Playing at football or rowing.....	600	"	"	"

Applying this rule to the typical ration, it will be seen that the quantity of heat formed by the amount of food represented in the table would keep a man at light muscular exercise for ten hours, using 1,700 Calories, and supply him at rest and asleep for fourteen hours, using 1,191 Calories.

Another method of judging a balanced ration is by securing the ratio of the protein consumed to the total amount of carbohydrates, plus the amount of fat multiplied by $2\frac{1}{4}$. If the result is a small numeral, 4 or 5, it is said to be a narrow ratio. If it is a large numeral, 6 to 9, it is said to be a wide ratio. Determining the nutritive ratio of the digestible food in the table on p. 150, we find that the carbohydrates, 371 grams, plus the fat or oil, 102 grams multiplied by $2\frac{1}{4}$, and their sum divided by the quantity of protein, 115, gives a quotient of 5.2. The nutritive ratio of the typical ration above described is, therefore, 5.2, and is neither a narrow nor a wide ratio. For a

man at hard work the quantity of carbohydrates and fats would be very much increased. In other words, the daily ration for a hard-working man should contain more fat and more carbohydrates in proportion to the amount of protein than the typical ration which is given. The nutritive ratio for a man engaged in hard or violent physical exercise should be a wide one, represented by figures extending from 6 to 8.

In the above computation I have adhered to the common experience in regard to human diet. I have not considered the modern theories which hold that the protein of the average diet is proportionately too high. If, for instance, the protein of the daily ration was reduced to 90 grams, the amount of heat energy in the typical diet would be reduced by approximately 100 heat units. In this case, it would be necessary to increase the carbohydrates or the fats. If the increase were solely in the carbohydrates, it would require 24 grams additional. If it were wholly in the oil or fat, it would require 10 grams additional. In other words, whenever one class of ingredients is diminished in a ration, in order to secure the proper amount of heat, the other classes of nutrients must be increased in thermal proportions.

By far the greater number of competent judges are opposed to the extreme reduction in protein advocated by Chittenden and his school. At the same time there is a general feeling that the nutritive ratio could be widened (that is, the protein lowered and the carbohydrates and fats increased) from 5.2 to 6.5 without danger, and perhaps with benefit. Personally, I am of the opinion that it would not be wise to diminish very greatly the average quantity of protein in a man's diet, and in this I believe the far greater number of investigators and experts agree. On the other hand, it is undoubtedly true that in many instances and in many occupations, especially those of hard labor, the proportionate amount of protein in the diet might be materially diminished with favorable results. It will require a much more extended study of the subject before it can be safely said that the typical diet in the table above should be very profoundly modified.

There is one other reason, and a cogent one, why no greater amount of protein should be eaten than is necessary. All protein ingested must be at once cared for. Fat can be stored. Sugar is converted into glycogen. Protein must

be used daily as it is eaten. Thus an excess of protein increases the amount of heat and places on the excretory organs an instant burden.

In presenting this typical idea of a balanced ration I am fully aware that important departures therefrom are constantly occurring and must be regarded as normal. In the extensive studies of human dietaries made by the Department of Agriculture, under the direction of Professor Atwater and others, the ratio of protein to the carbohydrates and fats, that is, the nutritive ratio, varied from 4 to 9.3. The widest ratio, 9.3, was found among negro families in Alabama and Virginia. The lowest ratio was found in the case of a Japanese professor.

I do not lay very great stress on the idea of securing constantly a typical balanced ration such as that described. A most important fact in connection with this discussion is that the human animal, when he has access to foods of various kinds—in other words, in what we would call a normal condition of life—*naturally* selects a ration which is so well balanced as to require but little amendment. The departures from a reasonably well-balanced ration are due not to human selection but to the artifices of man in denatur-

ing natural food products. The human animal who has access to nature's stores of foods does not require a trained dietitian to write a menu for him. Inasmuch, however, as a large percentage of us have access only to prepared foods, it is well to be on our guard. Not only are we likely to get an excess of fat and carbohydrates and a deficiency of protein, but also we are in greater danger of living on demineralized foods, and thus suffering from the threatening effects of mineral starvation. Even if we eat only whole cereals, we do not get a proper balance, because of the incompleteness of the basic mineral elements and the tendency to get an excess of acidic matter (phosphoric acid).

INSUFFICIENCY OF A MONO-CEREAL DIET

Late investigations in nutrition have shown that even wheat, which is the most evenly balanced ration among the cereals, is not suited alone to maintain normal life and growth nor to secure normal reproduction of the species. By reason of the large quantity of phosphoric acid in wheat it does not supply sufficient basic material to promote and continue all the natural functions. When wheat alone is used as a diet an

additional quantity of basic materials is required. The mineral mixture intended to supply the basic materials in a too-acid diet, which was used by McCullom and Davis (*Journal of Biological Chemistry*, July, 1915, p. 625), consisted of the following ingredients: Sodium chloride, 12.31 per cent.; acid potassium phosphate, 28.08 per cent.; acid calcium phosphate, 0.74 per cent.; dry magnesium sulphate, 1.56 per cent.; magnesium citrate, 5.75 per cent.; sodium citrate, dry, 3.12 per cent.; calcium lactate, 46.80 per cent.; ferrous lactate, 1.64 per cent. The elemental constituents (100 parts) of this mixture are as follows: Sodium, 5.67 per cent.; potassium, 12.6 per cent.; lime, 6.89 per cent.; magnesium, 0.89 per cent.; chlorine, 7.47 per cent.; phosphorus, 5.17 per cent.; sulphur, 0.42 per cent.; iron, 0.319 per cent.

While in certain conditions a distinctly acid ration is tolerated for a long while, yet in the end various disturbances occur, and especially a menace to posterity. McCullom and Davis conclude from the results of their investigations that "Growth to the normal adult size at the usual rate and continued well-nourished appearance is not sufficient evidence that a ration is fully adequate. Only when normal reproduction and

rearing of the young is repeated at normal intervals can a ration be said to be physiologically sufficient."

One chief purpose of having a diet properly balanced in respect of basic mineral constituents is to avoid that end state of excess of acids which sometimes promptly, but more often after many years, brings on a state of chronic ill health.

ONE CLASS OF FOODS NOT A SUBSTITUTE FOR ANOTHER

It is well to heed this additional caution in regard to foods, to avoid the fallacy of thinking that one class of foods may be fully substituted for another—as, for instance, fats substituted for carbohydrates or vice versa. Theoretically, such a substitution would not unbalance the ration if it were made according to thermal equivalents. In reality, however, such a substitution would unbalance the ration in this respect, that it would present to the digestive organs an excess of one or the other of these classes of foods, and thus interfere with nutrition in a very sensible manner without interfering with the quantity of potential heat-energy ingested. The man who is possessed by a theory in regard to foods not based upon sound dietetic data is always in danger of derang-

ing his ration in a manner whereby injury may occur.

If he should live on fruits principally, he would have a very wide nutritive ratio, because he would eat a very great excess of carbohydrates, principally sugars. These, of course, would furnish heat and energy in sufficient quantity if enough of them were ingested, but would not form a well distributed ration. In like manner, one who made his diet chiefly of nuts would probably get a large excess of protein and fats over the total amount of starches and sugars. In this case, however, the heat-forming elements of the diet would be largely fats instead of carbohydrates, and the character of the ration would be greatly disturbed from that which nature intended. Again, if one should confine his diet chiefly to meats, he would certainly have a very narrow nutritive ratio, as the lean meats are chiefly protein, and the fat is rather incidental. There would be, in my opinion, sooner or later, a grave disturbance of nutrition if a diet composed chiefly of meat were too long continued.

ALARM SIGNALS

Nature has provided alarm-signals for dangers of this kind. If a man is confined to a diet composed largely of cured, salt meat, nature runs out the scurvy-signal of danger. If he lives almost exclusively on polished rice, nature's semaphore displays the danger-signal of beri-beri. If his nutrition in general is low and insufficient, according to the recent reports of the Public Health Service, nature signals with pellagra as its sign of danger.

It is now becoming a popular practice among a certain school of sanitarians to belittle the importance of pure and wholesome food in the diet, and to magnify the other elements of sanitation at the expense of pure food. All the principles of sanitation are essential, and there is none that is of greater importance than that which relates to a properly balanced ration consisting of pure and wholesome food in sufficient quantity to promote growth, preserve health, and guard against disease. It is not alone the infant that suffers from improper food. It is true that the infant is most susceptible, but the child and the adult yield sooner or later, and pay tribute to the evil effects of a poorly balanced diet or one based on unwholesome elements.

LESSON XI

ECONOMY OF NUTRITION

TOO much stress is often laid on the gastronomic function of food. Let us chiefly consider food simply as nutriment. Due to war conditions in Europe, there is now a world-hunger such as never was known before. Are you interested in food as a hunger-satisfier? Are you willing to nourish yourself and your family just as well as you are doing now at half the expense? Or do you think it noble and aristocratic to pay twice for what you eat yourself, while a human brother, driven by fire and sword, is perishing of hunger?

If the American people would consent to nourish themselves scientifically and economically—for the terms are almost synonymous—they could generously feed every starving person at home and in Europe without contributing a cent over what they would save from this proper economy in nutrition. One simple example illustrates the whole situation. We pay today 300 per cent.

more for the cereals which have unfortunately taken the name of "breakfast-foods" than the cost of production and their nutritive value justify. The same extravagance rules in practically all classes of foods, but not to the same astonishing degree. It is time to call a halt. It is time to return to the simple life.

CONVENIENCE AND HIGH PRICE OF PACKAGE GOODS

The various factors which have increased the expense of living have not failed to affect the price of foods. The convenience of package foods has led to a phenomenal development of foods more or less prepared for eating, and preserved in packages of various forms. Many years ago, in speaking of beverages in this country, I used the phrase, "We drink labels." Since the advent of package goods I can with almost equal truthfulness say, "We eat labels." The amount of money which is paid in this country annually for labels would, if it could be ascertained, reveal one of the most effective causes of increased living-cost. The business of printing labels for foods sold under brand names is a specialty which has grown to enormous proportions. Theoretically, the cheapest foods are those which can be secured in

bulk. In practice all foods must have some kind of a container, in order to be properly transported, subdivided, and sold to the retail dealer. The expense of the package, as well as of carrying, is justly added to the cost of the food. I am not speaking now of this necessary expense of containers for foods. I am speaking of the habit which in this country has grown to such enormous proportions of specially packing foods in artistic and often expensive covers, to attract the eye before the contents satisfy the stomach. To those in affluent circumstances such a practice is of little importance. To those in moderate or straitened circumstances, however, quite a different aspect of the question is presented. The good points of package goods must not be lost sight of: first, their extreme convenience; second, the facility with which food products thus contained are kept clean and wholesome; third, the economy of using up at once the contents of the package, so that none may be left over to be lost or wasted; fourth, the saving in the cost of preparation and cooking in the home. These are all points in favor of package goods, and should not be minimized.

COST OF DRIED BEEF

As I was writing this article a question was propounded to me as to the cost of dried beef. Shaved for ready consumption, the retail price of dried beef is now 50 cents a pound. I have just had my attention called to canned dried beef—although I do not know why such products as cheese and dried beef and cured ham should be canned. The particular can of beef to which my attention was called contained $3\frac{1}{2}$ ounces, and sold for 18 cents. At this rate a pound of beef would cost 82 cents. I have just eaten a palatable and well-known preparation of wheat. I asked how much it cost a pound. The answer was, “Ten cents.” This was so much less than I anticipated that I called for the package. In rather small letters I read, “This package contains 5 oz. net weight.” At this rate a pound cost 32 cents; wheat costs 2 cents a pound; here is an increase of 30 cents, a percentage increase of 1,500!

PRODUCER *vs.* CONSUMER

It is always important, and especially so just now, to know something definite respecting cheap and nutritious foods. The following table offers

a comparison of the prices paid to the producer and those paid by the consumer :

	To the farmer or producer, per lb.	By the con- sumer, per lb.
Wheat	\$0.02	\$0.04 to .32
Indian corn	.01½	.04 " .40
Beef on the hoof	.07	.14 " .35
Potatoes	.01¼	.03 " .04
Butter	.25	.30 " .40
Oleomargarine	.15	.20 " .25
Eggs (per dozen)	.25	.35 " .50
Lard	.08	.14 " .16
Fresh fish	.05 to .15	.10 " .25
Dressed chickens	.10	.18 " .30
Turkeys	.12	.20 " .30

These prices vary from time to time, but very nearly represent those now prevailing. Many of the above-named articles could be purchased by the consumer directly from the producer, or, at most, with the intervention of one intermediary. In point of fact, however, even when bought in large quantities, the consumer as a rule pays a considerably higher price than that received by the producer. For instance, dressed and cooled beef suitable for cooking will range from 14 cents a pound for the cheapest cuts to 35 cents a pound for the best cuts. An average of 20 cents a pound, therefore, is a reasonable estimate. Apples, turnips, carrots, and potatoes may be

bought by the bushel even by a single family. The price of good eating-apples by the barrel today is \$3, and potatoes by the bushel, 65 cents. If bought at retail, in the usual small quantities—by the half-peck or peck—the prices will be practically double those named. It is highly advisable that groups of families living near each other buy such staple articles as those named in bulk.

I have just had some experience in doing this. A barrel of good eating-apples, Grimes Golden, was purchased for \$2.25 and divided among four families. In this way practically all the apples will be consumed, and there will be little loss by decay. I have also had experience in buying fresh fish at the wharves for two or three families. While fish was retailing at from 10 to 18 cents a pound it was purchased at the wharf at from 5 to 8 cents a pound. Freshly opened oysters can be had in like manner, and you can wait while they are opened.

This is not the place, however, to illustrate the economies of marketing. In the examples which are given I am using the price which the ordinary consumer, buying, however, in some considerable quantity, would be likely to pay. There is no doubt that great economies could be secured by

a union of neighboring families in the manner just suggested. Special examples will show how small a sum may be devoted to securing a maximum degree of nourishment. But before giving these examples I will answer a question which has often been asked me in regard to the economy of using oleomargarine. Inquiries in the market have led me to believe that good, wholesome oleomargarine, uncolored, may be secured at the markets at about 10 cents a pound less than butter. It is quite equal to butter in its chief nutritive function—the production of heat. It is decidedly inferior to butter in flavor and in the possession of minute quantities of unseparated constituents that stimulate growth. As an economy in nutrition it may safely be commended to healthy grown people. It is, I think, undoubtedly true that in most cases an uneducated palate would not distinguish between butter and oleomargarine except when the butter is slightly rancid. Under standard conditions oleomargarine keeps very much longer without exhibiting rancidity than pure butter does, and, therefore, the frequency with which rancid oleomargarine is met in the market is much less for equal quantities consumed than it is for butter. Again, it must not be forgot-

ten that butter fat is the natural food of the young, and it would be undesirable to substitute oleomargarine for butter or cream in the nourishment of young children. Late investigations have shown that butter contains some constituent, perhaps a lecithin, which is a powerful stimulant to growth, and hence oleomargarine should never be substituted for butter in a child's diet. The man at hard manual labor can eat it freely. The question of buying tub butter at 34 cents instead of print butter at 38 cents was raised by a correspondent. There is no reason why this should not be done, provided the bulk butter is of equal quality.

LESSON XII

FADS OF NUTRITION

THE art of feeding men and women ought to be based on scientific truths. Surely so common a phenomenon as human nutrition is capable of scientific study and elucidation. While the science of feeding pigs and poultry, cows and calves, and horses and sheep is now in a state of satisfactory exactitude, the science of feeding man is far from that realm of exact knowledge which is capable of uniting different investigators or different promoters in a harmonious and concordant plan. This is due largely to perversion of taste by artificial systems of living, to the establishment of an unnatural craving for stimulants and sedatives, and to the great part played in the functioning of the digestive organs by the emotional, nervous, and mental states of the more highly organized human being. Then, too, the appetites of the lower animals are controlled by our higher intelligence, while our own appetites often run riot!

VAGARIES OF FOOD FADDISTS

There have sprung up various schools and cults of food faddists, driven with an enthusiasm and energy which are often measured by the lack of scientific knowledge. Even those who are students of the science of nutrition in a proper and systematic manner are often far from agreement on many fundamental points.

Many of the ideas which are prevalent concerning diet are based partly on tradition, without any scientific basis whatever, partly on theories more or less tinged with a scientific nuance, but vague, illogical, and inconsistent—and to a limited degree on solid facts and experiment. Unfortunately, also, the common notions relating to the nutritive value of foods are largely influenced by an immense volume of widely disseminated assertions found largely in advertising matter and published for purely mercenary purposes. As an instance of this I have just read a widely circulated advertisement of a nostrum in which the following language is used: "Meat forms uric acid, which excites the kidneys; they get sluggish and fail to filter the waste and poisons from the blood; then we get sick." Another advertisement will tell the reader that all his ills are due to

some other food product, and so the susceptible victim is driven almost to despair. Claims of excellence and peculiar adaptability to specific cases of malnutrition are continually paraded before the public, and have had a powerful influence in forming in the minds of their readers a most grotesque picture of nutritional requirements.

It appears to me that there is just about as much quackery in theories of diet as there is in therapy. One prominent idea of these articles is to lay a foundation for a simple gospel of nutrition not glorified with optimism nor charged with charlatanry. The exuberant theories which, mushroomlike, spring up during the night are already sunken and shriveled before the sun goes down. Among these theories many are commonly known: vegetarianism, exclusive meat diet, nut diet, fruit diet, milk diet, raw-food diet, sour-milk diet, etc. Practically all these theories are built about a crystal center of truth. Vegetarianism may have and does have at times broad-minded and deeply learned advocates who are able to present a well-nigh impregnable argument. It has an additional vogue because of the general over-indulgence in meat in many homes. The evil effects of eating too much meat are most com-

monly found in cities among those of sedentary occupations who need but little meat, and to a large extent among travelers.

Many foods are naturally preferred raw. That, however, is not a fact which could justify a plea to do away with cooking. Many nuts and vegetables and most all fruits are preferably eaten raw. That fact, however, does not prove that peanuts should not be roasted nor potatoes baked.

FUNDAMENTAL ERROR

The fundamental error in such fads lies in ignorance of the true functions of foods and of the consequent necessity of a ration so balanced as to offer all the elements necessary to encourage growth, restore waste, and furnish heat and energy. These unscientific applications of partial facts receive additional vogue because they often prove helpful in individual cases. The thoroughly bad methods of eating so commonly practiced are responsible for this phenomenon. One who has habitually eaten too much meat is at once benefited by a strict vegetarian diet. He who has eaten nothing but cooked foods over long periods is undoubtedly helped by turning to raw berries, nuts, and fruits. The excessive coffee-

drunkard gets quick relief by substituting a beverage made of parched cereals, chicory, or roasted bananas. We all know that help comes from a changed environment; change of location, new landscapes, ocean voyages, a visit to the springs, are all beneficial in chronic troubles. So, in like manner, a complete change of diet is likely to help a weary stomach which for long periods has had no change in its ingested contents. Nevertheless, the common fads in diet are fundamentally unscientific and are repugnant to the generally accepted principle that man is an omnivorous animal. The rapid progress in experimental determination of the facts of the phenomena of nutrition is shedding valuable light on all these problems. Well-informed people are no longer quite such easy victims of the popular fad. They sift all such theories, to find the kernel of truth, and they reject the chaff.

REASONS FOR A VARIED DIET

A complete vindication of the desirability of a varied diet is found in the latest additions to the sum of our knowledge of digestion and assimilation. The essential elements of foods—the carbohydrates, proteins, fats, and minerals—are pre-

sented in entirely new aspects. In some forms of foods these elements are found to be much more useful than in others. The old rule of regarding these elements as of equal nutritional value, no matter what their sources, has been proved unreliable. The sugars are not by any means of the same value. The starches, long regarded as of equal worth, are now known to be unequally resistant to the action of the digestive ferments. Their nutritional value doubtless varies as do their differences in constitution. There is a grave question as to the assimilability of the various forms of phosphorus. The organic forms of phosphorus, such as the lecithins, doubtless have a very different rôle in the living organism from the mineral phosphates, such as those of soda and lime. Greatest of all, however, are the wide differences in the value of protein nutrients. (Incidentally, numerous references have been made to these varying values in preceding chapters of this study.) Even in the same substance the proteins have widely varying functions. Thus, in wheat the glutenin is more valuable than the gliadin, and in Indian corn the most abundant protein—zein—will not alone promote growth. Among the fats and oils similar differences are known to

exist. Thus, butter-fat has a greater value in growth than many other fats and oils.

That life can be maintained on a single article of food for an indefinite time is doubtless true, provided that article contains all the elements of nutrition. There are two common foods that come very near complying with that requirement; namely, milk and wheat. In infancy milk is the only food that should be used. The best milk for the infant is that supplied by his mother. Quick-growing young, such as the colt and the calf, require milk of quite a different composition from that of the human infant. Especially do they require more protein, the tissue-builder. The milk of the cow contains twice as much protein as that of the woman; and this fact is not forgotten in modifying cow's milk for the use of the human infant. Milk is the wheat of the infant, and wheat is the milk of the adult. I mention wheat as the typical cereal. Some others, oats especially, have almost equal value. Indian corn, because of the amount of zein it contains, is not so well suited for growing animals as wheat. Yet while wheat will support adult life, it would not be sound dietetics, according to my view, to urge its adoption as the sole food of man.

MONO-DIET A POSSIBILITY

A striking case has just been called to my attention in a letter from an injured workman, who, by reason of a street-car accident, may never be able to return to his work as printer and book-binder. He asked if he could live on wheat alone, for if so he might be able to get on without appealing to charity. In reply I said, "Yes, I think you can live on wheat alone, in the form of whole-wheat products, but not on white flour alone." I called his attention to the deadly monotony of such a diet, and suggested that while the cost of living on wheat alone would, in his case of enforced sedentary habits, not be much over 1 cent a day (farmer's price), some variation should be provided if possible. By allowing 6 cents a day for food, or \$1.80 a month, 4 cents' worth of milk (one pint) could be added to the daily cent's worth of whole wheat. Such a diet as this will supply abundant nourishment to one enforcedly quiet. Five cents' worth of milk at the farmer's price, \$1.40 for 100 pounds, would be more than three pints. This diet is not a fad, in some cases, but a necessity, and it contains all the essential elements necessary to the nourishment of man.

In order to secure the specific benefits of each

food product the normal diet should be reasonably inclusive. Fruits, vegetables, nuts, cereals, dairy products, meats, and oils, all find a place. Some of these should be cooked and some used raw. Not many things should be eaten at any one meal. In the interest of correct nutrition, the principal dish of the meal, to whatever class it may belong, should be varied according to season and means. Thus abundant nutriment will be secured, the psychology of digestion be recognized, and the taste gratified. It seems to me that the victim of a fad must always be unhappy, and this mental condition will affect to some extent the normal progress of digestion. The best-nourished man is temperately and carefully omnivorous.

THE MISLEADING TENDENCY OF FADS

The seductive and misleading thing about these fads is that most of them, perhaps all, have in them a nucleus of fact. These schools may be broadly divided into two classes: first, those that believe that only vegetables should be used for foods, and, second, those who think that meats only are the proper foods. The vegetable wing of this force is by far the more numerous. There are

perhaps a hundred preachers of the propaganda of vegetarianism where there is one who clings to the theory of meat alone. I need not repeat here the reasons which I have given in a different place for my belief in the omnivorous nature of man. This belief is based not only on anatomical resemblance, but also upon practically universal experience. The number of persons who restrict their diet solely to vegetables or animal products is extremely small. If I should venture to say that it was one-half of 1 per cent., I would probably overestimate the numbers who belong to these cults. Apparently, from the amount of literature which is extant, nearly all of humanity would be embraced in these two schools, but you cannot always judge of the number of frogs in the pool by the resonance and rotundity of the chorus.

In a country as rich as ours and so abundantly supplied with food there is a very large percentage of our people who are overgenerous to themselves in the amount of food which they eat. I have said in other places, and I think it is true, that probably fifty people die of overeating in our country where one dies of starvation. While there are no means of securing any scientific data on this point, I imagine that I have greatly under-

stated the ratio. Especially among men and women who are well off, who are able to indulge their tastes and appetites, is there an enormous percentage of the overfed. When a man in middle life, or slightly beyond that, feels the effects of his active life and his generous diet in a loss of physical, and even of mental, ability, he is led to seek a cure. He goes to the sanitarium, where he is placed upon a restricted vegetable diet. At once he responds to this change. It is just what nature has demanded, after many years of excess in eating animal foods. Wonderful improvement is in evidence. After a few weeks the man leaves the sanitarium apparently restored to health and full of enthusiasm as to its cause. In this case a purely vegetable diet has undoubtedly been of most excellent service, because it was indicated by the previous excess of meat-eating. It would be unfair, however, to hold an instance of this kind up as an argument toward excluding all meat from the diet. Yet I praise the work of the vegetarians, realizing what a great benefit it has been to humanity, and I may say an increasing benefit. I myself advocate little or no meat for children and a much smaller quantity for grown people than we are accustomed to eat.

PROTEIN POISONS AS LIMITS OF LIFE

Attention should be called to the fact that most of the poisonous products formed in the body from the food consumed are derived from the protein of the diet. In the breaking down of the protein tissues, or in the final disposal of those portions of the proteins which do not enter into tissue-building, poisonous principles of a very serious nature are developed. If these are not promptly excreted from the body, serious consequences ensue. If protein in an undigested form, as, for instance, the albumen of the egg or any of the soluble proteins of foods, should be ingested directly into the blood-stream, most threatening disturbances would occur. Even after digestion, during which the protein is rendered soluble, being decomposed into proteoses and peptones, the injection of these bodies into the blood-stream in this form might result in serious poisoning. It is only after the protein is reduced to a much more simple form, by the activity of the digestive enzymes secreted by the pancreas, that it is ready to enter into the circulation.

ASSUMED CAUSES OF OLD AGE

Many authorities attribute old age and its infirmities to the retention of these poisonous products of protein metabolism, either in the blood or in the alimentary canal. While I do not subscribe to the doctrine that all the evils of life result from poisoning by the degraded forms of protein, yet it is undoubtedly in the interest of good health and long life for the normal individual to secure the prompt and efficient excretion of the products of protein metabolism. If we should die only when poisoned by the digestive residues of fats and carbohydrates, human life would be lengthened to an almost interminable degree. However, there are few benefits in the world without their attendant dangers, and the fact that proteins are, in their final disposition, the most dangerous element of food does not alter the fact that they are also the one most essential to the building of the body. It simply remains for us to learn their nature and action, and use them intelligently—so that they shall serve and not hinder sound health.

I cannot, therefore, quite agree with those scientific men who base their opposition to the eating of meat upon the fact that the end prod-

ucts of digestion of meat are more poisonous and do more to hasten senescence than the similar end products of vegetable foods. It is not quite fair to attribute to a meat diet the autotoxins (self-poisoners) of ordinary digestion. In other words, we ought not to charge meat with all the evils of autointoxication. Our knowledge of the bodies produced during digestion or by bacterial activity after digestion is too limited to ascribe to them the sole efficient causes of old age. If it were possible, without injuring the health in any way, to cut out the large intestine, where these bodies are supposed to congregate, so that all of them as they arise would be at once eliminated from the body, it would not, in my opinion, defer old age. Our bodily powers at a certain period of our life would begin to fail, our hair would begin to turn gray, our natural senses to be dimmed, and all of the phenomena which attend old age would undoubtedly come upon us practically as early in life and with such overwhelming effects as they do at the present time.

NOT A TENABLE THEORY

The theory which I am combating is that old age is produced solely by these autotoxins result-

ing from the digestion of our food, and the vegetarian claims that they practically all come from meat foods. This claim I do not believe to be justified by existing scientific data. We could have a bacterial flora of innumerable numbers producing quantities of end products which are poisonous and hurtful with purely vegetable foods, as we have them now with our mixed foods. To three of these end products are particularly ascribed harmful effects. They are indol, skatol, and phenol. These bodies become conjugated with the sulphuric-acid radicle and are eliminated as sulphuric-acid compounds in the urine. That the retention of these and similar bodies in the system would produce harmful effects there is no doubt, but that their production could in any way be prohibited by any kind of a restricted diet that would sustain life in my opinion is impossible. Hence the idea that the eating of meat in moderate quantities shortens our lives seems to me to be untenable.

PREVENTION OF OLD AGE

Almost every day someone advertises a specific against old age. There has just come to my table as I write this a typical illustration of these dis-

coveries of panaceas to preserve youth and retard old age. The discoverer of this perfect panacea writes as follows:

“In looking over the July number of *Good Housekeeping* I noticed your article on ‘Foods, Sanitation, and Health,’ and was very much interested in said article. But I take exception to what you say about blood purification in the following statement: ‘There is only one way to purify the blood, and that is by hygienic living.’ I claim to have discovered a perfect blood purifier, and if you will carefully read the testimony of letters embraced in circular enclosed in this letter you will find many strong endorsements for my remedy for blood purification.

“Now, in compounding this remedy, I use sulfur, glycerine, powdered slippery elm, and oil of wintergreen. Consequently there is nothing in it that will harm an infant, and if we believe one-half of what people say about it, it is one of the most wonderful discoveries ever made.”

Attached to this letter were printed testimonials, with pictures of men seventy, seventy-five, and eighty years of age, with all the appearance of youth ascribed solely to the virtues of this remedy. The writer of the above is perfectly honest and sincere in his belief that a little of

the flowers of sulphur once a week will ward off old age and conserve youth. If one were suffering from constipation there might be some benefit obtained by a laxative, though the continued use of a drug for this purpose, in my opinion, in the end will do more harm than good.

WHISKY AS A LIFE-PRESERVER

Whisky is also largely advertised as a preserver of youth and an enemy of old age. Old men are prolix with testimonials to the effect that their extreme vigor and long life are due to drinking Duffy's Malt Whisky. When we consider that competent students of sanitation and physiology are of one mind in regard to the effect of whisky, how can we patiently contemplate such attempts as are made through the newspapers and magazines to increase the consumption of whisky under the false idea of lengthening life? The data in regard to alcohol are so conclusive in the other direction as to make it incredible that any editor or manager of a newspaper who has any interest in the welfare of the public would consent to carry such dangerous and misleading advertisements in his columns. Dr. Irving Fisher,

in speaking of the effect of alcohol on health, says:

“The best authority on the subject of the mortality of alcohol-users in this country is undoubtedly Mr. Edward Bunnell Phelps. In his book on this subject he shows that of the male deaths in the area of the United States for which we have accurate registration of deaths, between the ages of twenty and seventy-four, 12 per cent. of the cases of tuberculosis of the lungs are due in whole or in part to alcohol, 16 per cent. of the deaths from heart disease, 22 per cent. of the deaths from pneumonia, 22 per cent. of the deaths from paralysis, 22 per cent. of the deaths from apoplexy, 23 per cent. of the deaths from diseases of the arteries, 30 per cent. of the deaths from Bright’s disease, 67 per cent. of the deaths from cirrhosis of the liver. Mr. Phelps also states: ‘Roughly speaking, alcohol may have been directly or indirectly responsible for about 66,000 deaths in continental United States in 1908, or for about one in every thirteen deaths at adult ages.’ ”

I have given a somewhat extended space to the discussion of the proposition that the use of alcohol prolongs life, because I believe that doctrine is in itself most pernicious and threatening.

LESSON XIII

THE SOUR-MILK PROPAGANDA

QUITE a different kind of life-preserver is the recent theory ascribed to Metchnikoff, that the use of sour milk is one of the best aids toward reaching a green old age. This theory is based upon the fundamental idea that life is shortened by reason of the activities of the bacterial flora of the large intestine, producing toxins which tend to shorten life. It is well known that in a medium where different forms of bacteria grow there is usually one which is dominant and by its vigorous growth restricts or destroys the growth of other kinds of organism. The farmer knows that if his corn gets a vigorous start it will prevent the weeds from growing; if, on the other hand, the weeds get the start, they will prevent the corn from growing. The fundamental idea of the sour-milk theory is to introduce into the large intestine living bacilli; that is, the organisms which produce acidity in milk. These bacilli are vigorous in growth, and thus, based

upon the principle above outlined, will limit the activity, or even prevent it, of those organisms which produce toxic bodies. Metchnikoff observed that among the mountainous regions of Bulgaria there was a very large percentage of centenarians, larger than in most countries. The conclusion derived from this observation is that because these mountaineers drink large quantities of sour milk their life has been prolonged thereby. This is another illustration of assigning a false cause for a true cause. A mountainous country is always conducive to old age. The pure air, the exercise, the environment, the simple food which the mountaineers live upon, are all helpful. Notwithstanding this fact, however, the average length of life in Bulgaria, as established by careful vital statistics, is less than it is in the United States. In the report of the mortality statistics (1913) of the Census Bureau the average death rate of the United States, 1901-5, was 16.2 per 1,000, and during the same period in Bulgaria it was 22.5 per 1,000.

I do not like to discuss this part of the question immediately after the remarks I made in regard to the life-preserving qualities of a certain brand of whisky. Sour milk and whisky are in

quite different classes. Sour milk is a wholesome and delicious food, and, therefore, as such tends to prevent disease and prolong life. That sour milk is a specific against the particular cause of old age which has been assigned does not appeal to me as true.

KINDS OF SOUR MILK

Many investigations have been made of the claims of sour milk in its different aspects as a food product. There is no doubt that there are many conditions of digestion in which sour milk of some description is indicated. I have myself seen most happy effects follow the judicious use of kumiss (not a trade-mark product) in cases of low assimilation and low nutrition. Kumiss is one of the types of milk in which not only has there been an acid but also a slightly alcoholic fermentation. There is another class of milks in which only acid fermentation is produced, and this is easily accomplished by means of a proper ferment, of which the *Bacillus Bulgaricus* is a type. The acid which is formed by such a fermentation is, of course, chiefly lactic. Of the fermented milks which contain alcohol, kumiss sometimes contains as much as 2 or 3 per cent., though

usually not more than 1 per cent. Milk soured by a sound, pure-bred lactic-acid organism is, therefore, to be preferred to kumiss in a child's diet.

While sour milk has its uses, and in certain cases of digestive disorders is undoubtedly beneficial, there is no established scientific basis for the popular fad of today. This has been admirably set forth by the *Journal of the American Medical Association*, from which many of the following facts are drawn.

KINDS OF ARTIFICIALLY SOURED MILK

The acid-fermented milks have been long known in Asia, Africa, and the eastern countries of Europe. In the United States buttermilk is practically the only acid-fermented milk which has been generally used. Among the Scandinavian people a thick, fermented milk known as *tätemelk*, or *kjernemelk*, is used. The most interesting of the acid-fermented milks is the one known as *yoghurt*, which originated in Bulgaria, and is prepared in the following manner: Cow's milk is evaporated in a clean vessel over a slow fire to about half its volume. It is then cooled to 45° C. (113° F.) and inoculated with the ferment "maya," a small remnant of a previously pre-

pared lot being used. The ferment is thoroughly mixed by stirring, and the vessel is wrapped in skins and cloths so as to maintain the desired temperature. (At a lower temperature abnormal fermentations cannot be avoided, since the ferment contains many micro-organisms. The chief acid-forming element of the ferment is the Bulgarian bacillus, and the best temperature for its use is about 45° C.) The souring of the milk is completed in from ten to twelve hours. The finished product has the consistency of a pudding, and is eaten mixed with brown bread or sugar. This half-solid milk is very palatable to most persons, especially to those accustomed to it. It is claimed by some analysts that the casein of the milk has been rendered more soluble, but this has not been established by competent scientific evidence. There is, however, no doubt of the fact that the casein, or curd, is more easily digested when prepared in this way, because it is more finely divided and the digestive enzymes have better access to it than they have in the thick curd formed from milk itself; therefore, in many cases this acidified milk has an advantage as food for infants and invalids, because it is somewhat more easily digestible.

The yoghurt which is prepared according to the above recipe is not usually found in western Europe or in this country. The domestic product is prepared from whole milk, without concentration; it is always advisable to have it boiled, cooled, and inoculated, to destroy the bacteria in milks common on the market.

CAUSE OF POPULARITY

The widespread popularity of such sour-milk products and the commercialization and exaggeration of their therapeutic value are due largely to a mistaken application of Metchnikoff's suggestion that the presence of the *Bacillus Bulgaricus* in the digestive tract prevents premature senility due to auto-intoxication or other disorders. That this claim rests upon no definite scientific data is now acknowledged to be true. Likewise the generally circulated ideas that this sour milk is not only a prophylactic against old age but also a remedy for many of the ordinary diseases, must be taken with a grain of salt. All kinds of stomach troubles, scarlet fever, whooping-cough, anemia, scrofula, gall-stones, diabetes, chronic rheumatism, dysentery, appendicitis, tuberculosis, and a host of other diseases, are said to be cured by the

use of yoghurt. Too much caution cannot be urged in regard to claims of this kind. While it is undoubtedly true that artificially soured milk has its uses, and in many cases very valuable uses, the idea that it will postpone old age and cure all kinds of disease is wholly without scientific warrant. Even if we should inject into our stomachs large numbers of the Bulgarian bacillus with our sour milk, we have no reason to believe that they will ever survive until they reach the large intestine, where most of the damage done to life by auto-intoxication is supposed to take place. Extensive experiments have shown that the viability of these organisms, up to the point where they can be effective in the large intestine, has not been fully demonstrated. It has been established that the intestinal flora have not been materially altered by this kind of feeding, and that often Bulgarian bacilli could not be found in the excreta a short time after feeding of the sour milk was discontinued. Since more than 90 per cent. of all the bacteria which are found in the excreta are dead, it is not likely that any system of feeding will permanently increase the number of living organisms, and we must admit that a dead *Bacillus Bulgaricus* is certainly

without value as a means of prolonging life. The fact, therefore, that enormous numbers of dead organisms are found in the excreta after the use of the Bulgarian sour milk, is no proof that they were killed by that means.

Extensive studies of commercial preparations have shown that many of them contain few if any living organisms, being far inferior to fresh buttermilk. Moreover, the Bulgarian bacillus appears normally in the intestines and is found in the feces of persons who have not been taking such artificial preparations.

Generally, the good effects, if any, that are found to attend the use of sour milk in the diet are associated with other reforms which are quite as important. Metchnikoff himself has not stated that the Bulgarian bacillus alone can defer old age, but that a regular diet, with a decrease of meat and a general compliance with sanitary conditions, when accompanied by the use of sour milk, are valuable aids to health. This is probably unquestionable, but of the factors mentioned the sour milk has, perhaps, the least to do with it. In general, it may be said that it is advisable from time to time to use sour milk in the diet, but not exclusively, and only under such conditions as

may give an opportunity to insure its full nutritive and therapeutic effect. The idea that man may live forever if he only uses enough of artificially soured milk is preposterous. The fame of a great man like Metchnikoff is somewhat tarnished by the unwarranted use of his ideas by promoters and manufacturers of fermenting-organisms.

MARCHING AND COUNTERMARCHING

Thus one reformer after another comes along with his panacea. In one case it is whisky; in another case it is flowers of sulphur; in another case it is sour milk; in another case it is a vegetable diet; in another case it is a restricted vegetable diet, such as fruits or nuts; in another case it is a raw-meat diet; in another case it is a strictly mono-diet, only one kind of food, one cereal or one fruit or one kind of nut or one kind of meat; in another case it is no food—fasting, which is the best of them all.

And so on the faddists come and go, marching and countermarching, with flags flying and drums beating, and humanity continues to die. The old Latin poet has very truly said, “*Medio tutissimus ibis*”; that is, if you keep in the middle of

the road you will be safe. This is a good motto in the choosing of a diet for long life. Select from all except whisky and other drugs those things which are pure, wholesome, nutritious, and palatable, and out of these build your diet, well-balanced, with all of the elements of nutrition and all of the materials necessary for repair, and you will live longer, be freer of disease, be happier, and render better service to humanity, than if you become a devotee of any mere fad or fancy.

LESSON XIV

INFANT-FEEDING

THE problem of infant-feeding is one of such supreme importance that it merits careful study of every parent and every guardian. I would go farther than this and say that it should be a special study with every physician and every hygienist. We call a physician whose specialty is diseases of children a pediatricist, which, when analyzed as to its derivation, is found to represent two Greek words which mean "the healing of children." It is indeed an important profession, and many a poor infant lies under the marble to-day by reason of the fact that the physician called to attend him in his illness was not skilled in such matters.

More important, however, is that treatment of a child which would avoid the most common enemy of the infant, an enemy under many disguises, which is best known by the title "summer complaint." The digestive tract of the infant is extremely sensitive to disorders and is far more

easily affected by improper food than the stomach of the adult. Not only the children of the poor, but of the rich; not only those of the educated, but of the ignorant, alike succumb to those dreadful maladies caused almost exclusively by improper food.

Statistics show a wide variation in infant mortality in various parts of the country. According to the latest statistics of some of the principal cities, the total mortality in the registration area is 170 per thousand under the age of one year. The registration area embraces that part of the country where the state law, and in the District of Columbia the national law requires the keeping of human statistics, otherwise known as vital statistics. Some of the laws are extremely crude, but if they secure a correct census they have the greatest value. The fundamental data which are necessary in vital statistics are births, deaths, ages of death, and causes of death. When these facts are correctly reported we get a line on the vitality of the community. We know their average life span, we know the character of the diseases to which they are most obnoxious, and we know, especially, how many of the little innocents who are helpless to care for themselves fall victims to

the indifference, the ignorance, or the love of their parents or guardians.

MOTHER'S MILK A LIFE-PRESERVER

I cannot emphasize too strongly the fact that the only real proper food for an infant is the milk of a healthy mother. The child at its mother's breast has a life-insurance policy, not payable at its death, but payable by its life. Unfortunately, in most cases vital statistics do not bring out clearly the number of bottle-fed or artificially fed children that die in proportion to the total number. What we want especially to bring out in all of its appalling nature the danger of the artificially fed infant is a set of vital statistics which will give the total number of infants breast-fed, the total number artificially fed or bottle-fed, and the number and percentage of deaths in each case.

An investigation made by Dr. Dublin in Fall River, Massachusetts, in 1913, has done this. Infants that were artificially fed beginning with the second week showed at the end of the first year a death rate of 421 per 1,000, while breast-fed infants in like circumstances showed only 131 deaths per 1,000. The death rates of the two classes

gradually approximated until at weaning time they were nearly the same. These data show the dangers of artificial feeding of infants in a most striking manner. The total number of infants under observation was 641; of these 565 were breast-fed and 76 hand-fed.

BEST TIME FOR WEANING INFANTS

From the statistics which are available and from our own experience we know how very much safer the breast-fed infant is. Unfortunately, too many mothers wean their children at the beginning of the warm season. I strongly advise the extension of the nursing period to fifteen months rather than to terminate it at ten or eleven months, on the approach of summer. The children that have the best chances to live are those that are born from October to February. These children, if fortunate enough to have a mother capable of doing so, are at the mother's breast during the warm season of their first year. They are well along in their second year before the second summer arrives. This point ought to be of significance to parents who may determine the period at which their children are born. The infant which has the worst chance, as a rule, is the

one who spends his first summer on the bottle, for he is destined to bear the vicissitudes of the summer at the age of least resistance.

The older the child is at the beginning of summer, the better chance he has to live. We face this problem, nevertheless, of necessity or misfortune which consigns the new-born infant to artificial feeding. Whether this arise from the illness or death of the mother, or from her inability to secrete milk, or whether it is an unfortunate and misplaced and almost criminal choice, makes no difference to the victim. Whatever the cause of his artificial nourishment is, the dangers are the same.

HAND-FED INFANTS MAY BE SAVED

Modern sanitation and medical science have demonstrated that even the artificially fed infant may be saved in most cases. It is useless to discuss the various preparations which are offered for infant-feeding. Not one of them is worthy of confidence. There are some which are used in modifying the milk which is given to a child which may be helpful at times and under certain disordered conditions, but the parent or guardian who depends upon them solely for the infant's

nourishment is more likely to have a doctor's and a funeral bill than a healthy child at the end of the first year. Pure, clean, fresh milk from healthy cows is the one substitute which commands confidence. In a matter of such importance one would think that communities and parents would actively collaborate in securing at least pure milk for the unfortunate infant deprived of its mother's breast. In some localities this collaboration is practiced, but, oh, how few they are! What success would a parent have, going into a strange town, in securing the kind of milk I have just described for his infant's nourishment? In most places no such locality would be discovered where pure milk, certified, and handled in a sanitary manner, could be had. The hand-fed infant on a journey is in as much danger, almost, as if he were a soldier in the trenches. At any moment the food which he consumes may carry the deadly bullet in the form of an organism which will produce disturbance, diarrhea, and death. It is the duty of every community to provide at least one station where clean, pure milk can be had. If it is impossible to do this for the whole community, it should be done for the infant and the child. More important by far than the fire department, the

police department, or the school department, is such an institution in every village and in every city.

LIFE FIRST

“Safety first” is a motto which now enjoys great popularity. The motto for the infant and the child should be “Life first.” It is not so much accident that he is to be guarded against, as is indicated by the usual application of the motto “Safety first.” It is disease which threatens, accidental perhaps, but a no less preventable accident than being run over by a motor-car or a fire-truck. There may be someone in every town who reads this book who will take sufficient note of what I say to induce him to become a leader in organizing in every locality a depot where pure milk can be secured. The public school, the pulpit, the newspaper, the rostrum, must be utilized everywhere to guard the very threshold of humanity from the inroads of disease and death.

Milk is safer when taken from a number of cows, unless the particular animal from which the milk is derived is thoroughly healthy. It is not sufficient that the animal be free of disease, especially tuberculosis, though these conditions are

fundamental. It must also be reasonably free of the natural contaminations which the milk secures from internal and external sources. We are well acquainted with the sanitary methods by means of which the cow, the milker, and the vessels can be kept thoroughly clean and thus the milk be protected from external contamination. This is not quite enough when the life of the infant is at stake. There are things in milk which are not milk, even when taken from the healthiest cow and in the most sanitary manner. The udder is an excretory organ, not only of milk but also of certain other products which naturally arise. The white corpuscles of the blood, the epithelial scales, excretions from the membranes of the udder, are found in what is known as clean, fresh, pure milk. You need only to subject this milk to separation, where the cream and the skimmed milk may be obtained separately, to find what I mean. On the walls of the separating machine, after the operation is over, will be found a sticky, slimy mass, separated from the milk, and which is not due to any lack of caution or sanitation or care of health. It is advisable, therefore, that all milk intended for infants and children should first be separated when first drawn from the cow and the stream of

skimmed milk and cream allowed to flow into the same receptacle, thus re-forming the milk with all of its milk elements, and with the slime, the cells, and the detritus removed. This re-formed milk as it comes from the separator is to be instantly cooled, and is then ready for infant use after warming to blood-heat.

DIFFICULTIES OF PRODUCING PURE MILK

Where apparatus is at hand the cost of thus purifying the milk is so slight as to leave no excuse for not practicing it. One thing is largely in the way of this special purification of milk, and that is the early hour of moving the milk from the dairy to the point of consumption. If the milk train leaves early in the morning, it does not give time for the dairyman to separate and clarify his milk, unless the milking hour is put so early in the morning as to be a burden both upon the milker and the cow. The practice of milk delivery is at fault in this, that people as a rule want their milk delivered early in the morning. This means that practically no milk is delivered in the city the morning it is milked. All the milk so delivered may be twelve or twenty-four hours old, at least. The proper time to deliver milk is about the

middle of the day. In this way the morning milk can be delivered to the consumer within a few hours after milking, while the evening milk will be in the hands of the consumer not to exceed twenty hours after milking. The better plan, of course, is to have two deliveries a day, but this adds too much to the cost. The evening milk could be delivered in the morning and the morning milk in the afternoon. Distributers can do this by charging an extra price, which the consumer ought to be willing to pay for the sake of his infant and his child. It is strange to me to see people in good circumstances, who keep a car, a butler, and two maids, and spend twenty-five dollars a week on amusements, bristle with resentment when they are asked to add two or five cents a quart to the milk for their own children. This indifference to the welfare of the child and this economy are not faults of character, but are the results of lack of education. "Pigs is pigs," as the author has well illustrated, but milk is not milk, as I have just explained. Milk is any old thing, reeking with dirt and as old as the natural law of the formation of acidity will permit, which the producer and the dealer are willing to palm off upon the people.

I don't know of any reform more imperative

than that connected with the milk service. I don't know any way in which paternalism could do so much good as in the town or city taking over the distribution of its own milk supply, thus lessening expense, and thus paving the way for a much better quality. I know something from both ends of the line in regard to milk production. I am a milk-producer, and know the great difficulty of and extra expense incurred in producing clean, fresh milk. I am also a consumer, and know how hard it is to reconcile the item of expense with that of our neighbors who pay eight or nine cents a quart for their milk while we pay from twelve to twenty cents a quart for ours. If I have to economize, it will not be on the milk for my children. It will be on their clothing and schooling and expensive foods, and not on that staff of child-life—milk.

MODIFYING MILK

The milk of the cow is not identical in composition with that of the mother. Nature has adapted the food of the infant and the child to its needs. Perhaps I had better not say that. The needs of the infant and the child have secured the secretion of a milk suitable thereto. The child

is a very slow grower. He is not of full stature until he is twenty-one, and sometimes not until he is older than that. The calf is a fast grower. He reaches his full stature at from three to four years. The tissue-building material of cow's milk is therefore very much larger in percentage than it is in the milk of the woman. This is most strikingly seen in the item of protein, the great tissue-builder. The milk of the cow contains $3\frac{1}{2}$ per cent. of protein; the milk of the woman contains from 1 to $1\frac{1}{2}$ per cent. The cow's milk is, therefore, not suited to human infant consumption without modification.

The simplest modifying element of milk is pure or freshly boiled water. When cow's milk is diluted with water the percentage of protein may easily be reduced to 2 or $1\frac{1}{2}$ per cent.; but this also reduces the quantity of fat and of sugar in the milk. To avoid this, the top milk, that is, part cream, may be selected for reduction, and thus the modified milk, reduced by water to $1\frac{1}{2}$ or 2 per cent. of protein, may still contain its 4 per cent. of fat. There remains now only to supply the sugar. This is done by using pure milk-sugar. If there is a tendency to overacidity, a little limewater may also be used, but only in moderation. As the

child grows the quantity of water added to the milk becomes less, and when he is one and a half to two years of age he is capable of assimilating the cow's milk without change.

I do not claim that this modified milk is as good as mother's milk. By no means. But it is so good that the infant and child who live upon it may not fear the dreadful disasters which I have pointed out.

The fundamental need of artificial feeding is pure milk. What may be said of the various infant foods advertised to the public? I answer, "They are excellent for grown people." The great majority of infants' foods, so-called, are modified starch. The infant's stomach is not furnished to digest very much starch. If starch foods are to be given, it is a mercy to the infant to have the starch first converted into sugar. There is an easy and effective way of doing this; namely, by the action of diastase (malt) on the cereals. The greater part of the starch which cereals contain, when subjected to the action of malt, is converted into a sugar known as maltose, which is far more easily digested and absorbed in the child's stomach than starch, and even more so, perhaps, than cane sugar.

There are certain disorders in child-life where milk "does not agree with the child," as we say, where additions of malted cereals may prove beneficial. The admixture of malted cereals with the milk in such cases is justifiable, but it should be done with moderation and careful study, and under the eye of a competent expert (hygienist or physician). There may also be mixed with milk in such circumstances a little cereal paste, that is, a barley or wheat flour boiled with water until it assumes a gummy or pasty condition, and a little of this may be added to the milk. It is not so important, perhaps, from a nourishment point of view as it is for a deterrent of the coagulation of the milk in the stomach into too large particles. There are preparations, especially of barley, on the market reduced to the very finest flour form which are much prized by some physicians and parents in the modification of milk.

I would not say that infant foods should not be used, but as long as the child is healthy on the modified milk without them, and as long as it is not constipated, the addition of any extraneous substance is inadvisable and not called for. The less we tamper with the fundamental food of the infant and the child, the better it will be. It is not

until the infant is ill, until that terrible condition produced by summer complaint is fully established, when its little life is ebbing away by reason of the disturbance of the intestinal tract caused by improper food, that we begin to realize how much it all means to us. In the grief of the father and the mother for the little one prematurely taken away there should be some little pricking of the conscience in the realization of the fact that it might all easily have been avoided. I am not optimistic enough to suppose that we shall ever get rid entirely of these fatal diseases of the infant. With the greatest care, with the most expert supervision, with the keenest attention to detail, there may be opportunities to introduce in the food the disturbing germ which will produce the disastrous effect. At least the parent or the guardian in these cases would not spend many terrible days and nights in self-examination and self-accusation of indifference and ignorance.

In all cases where certified milk, or milk of known purity and cleanliness, cannot be secured the market article should be subjected to thorough pasteurization at a temperature not lower than 145° F., for at least twenty minutes. Evaporated milk, which is sterile, when made of good milk, is

advisable where only poor fresh milk can be had.

It has long been recognized that the digestive tract of the infant and young child acts in a manner distinctly different from that of an older child or an adult. In a late article by Dr. McClendon (*Journal of the American Medical Association*, July 3, 1915, p. 12) is given a review of the data which have been established in regard to the digestive tract of the infant and young child. Dr. McClendon adds investigations of his own along the same line. He found that the acidity of the infant's stomach remains nearly stationary during the first hour after feeding, after which it rises steadily until the next meal. If this meal be delayed by as much as four hours, the acidity of the infant's stomach may be as great as that of the adult.

ACIDITY OF THE SMALL INTESTINE

The contents of the duodenum in the infant and young child are found to be more acid than the full stomach, and this in spite of the presence of the bile and pancreatic juice, which are recognized as of an alkaline character. Peptic digestion of nitrogenous foods would, therefore, continue in the duodenum of the infant, and this is peculiarly

desirable in the case of milk as a diet. The milk, although coagulated in the stomach, readily passes the pylorus to the duodenum, and hence if the duodenum were as strongly alkaline as it is in the adult the further digestion of the milk would be interfered with. Pepsin was found in the duodenum of infants, and this is confirmatory of the theory that peptic digestion continues. Trypsin, which is the nitrogenous digester from the pancreas, which is encountered chiefly in the small intestine of the grown person, is found in the duodenum of the infant, but was less abundant, even, than pepsin. As trypsin is complementary to pepsin, the fact that flakes of undigested protein may sometimes be found in the feces of the infant is thus accounted for.

Whether or not this acidity of the digestive juices continues throughout the small intestine has not been determined by experiment. The fact, however, that the feces of the infant are still acid leads to the conclusion that the intestinal juices of the infant are acid throughout the whole length of the digestive canal. This is a strong reason for not giving the infant starch, which requires an alkaline or only faintly acid medium. The infant and the young child do not excrete very much bile,

which is one of the principal alkaline secretions that neutralize the acidity of the stomach juices when they enter the duodenum. The small intestine of the infant, however, has an abundant supply of the fat-splitting ferment—lipase. Thus the infant's digestive organs are well adapted for the utilization of fat. There is also believed to be some lipase in the mother's milk, and the glands of the infant also secrete lipase.

Dr. McClendon asks the following pertinent question:

“Since the infant may some day become a man, the question arises as to what becomes of the digestion in the transition process. We observed that the infant's duodenum is not too acid for tryptic digestion, and, therefore, when the acidity of the intestine in the growing child decreases so that peptic digestion can no longer take place, it is still equipped with an efficient agent for proteolysis.”

Thus it is seen that there is a scientific basis for the theory that the transition of the dietary of the infant to that of the adult should take place gradually, as there is every reason to believe that the secretions which determine the character and rate of digestion are changed very gradually from

those of the infant, designed particularly for the digestion of milk, to those of the adult, where the digestive secretions are adapted to the general utilization of promiscuous food.

The supreme importance of a reasonably safe diet for hand-fed and weaning children is becoming more generally appreciated. The most fruitful field of labor in saving life is presented by this problem. Neglect here is speedily fatal. That municipality which offers unfortunate mothers a safe milk supply is more to be praised than for good schools, efficient police and fire departments and safeguarded public utilities. The safest supervisor of this commodity is the municipality. It is too vital to be left to the producer. Better dedicate the streets to the service of a corporation for street railways than to leave the helpless infants of the town to the mercy of uncertified milk. A few hundred dollars would bring into every incorporated community a safe food for the hand-fed infants.

LESSON XV

THE FEEDING OF THE CHILD FROM WEAN- ING UNTIL THE END OF THE THIRD YEAR

THERE is no event in the history of the child to which the mother looks forward with more foreboding than the weaning-time. I have already intimated that the best time to wean a child is in October or November. Hot weather brings the threat not only of bad milk but of debility due to the excessive heat. This latter threat is not at all mitigated by the common method of swaddling children. The diaper, while necessary for cleanliness, is a threat and a burden to the development of the child. If some genius would devise a means of cleanliness and at the same time do away with the diaper, he would confer a world-wide benefit upon humanity. But in addition to this the infant must wear long skirts, for what reason I do not know, and no one else does, and be bundled with interminable wrappings both by day and by night. The naked

child, lying on a fireless porch with the air of heaven blowing over him, would be the ideal of summer raiment.

PRINCIPLES OF WEANING

The first principle in weaning should be gradation. There should be nothing sudden. The time having been selected, and, in my opinion, it should not be before the twelfth month, though usually it is earlier than that, a careful study of the problem should be made and a plan of procedure mapped out. The family physician unfortunately is not always an authority in dietetics, and while in cases of disease he is to be first consulted, there are often wise and well-informed mothers who are better judges of how and when to wean a child than the general practitioner.

First of all, the supply of the clean, fresh milk described in the last chapter must be secured. Then the nursing-bottles, with nipples, methods of warming, and the means of sterilizing, are to be provided. These bottles are now made specially and provided with all necessary appliances for securing the proper temperature and manipulation. The dealer, however, cannot supply the sterilization. Rubber nipples are usually em-

ployed, and these are injured by boiling water. The nipple, after use, is to be thoroughly washed with warm water and then placed in an antiseptic solution (a 10 per cent. borax solution is the simplest and best), where it is kept until time for its next use. It is taken out of the solution by a pair of sterilized forceps and dropped into a vessel of freshly boiled water, still quite hot, and moved back and forth through this water until all traces of the borax solution are removed. Meanwhile the thumb and finger of the manipulator, which have been thoroughly cleansed and held for a short time in the borax solution, are rinsed with freshly boiled water, and the nipple is then taken and placed upon the bottle. The modified milk in the bottle is thoroughly stirred, in order that the cream may be uniformly distributed, and is then warmed to a temperature of 100° F. It is then ready for use.

It is a safe custom, where refrigeration is provided, to fill all the sterilized bottles with the modified milk when the solution is first made, that is, enough for twenty-four hours. These bottles are then stoppered with sterilized cotton and placed in the refrigerator and taken out one by one at time of use, and warmed as above described.

This is a more convenient method than keeping the milk itself in the refrigerator and making up each bottle separately. It is also a great time-saver. When the day's bottles are ready for cleaning they should be thoroughly rinsed out, each one as soon as the child is through with it. They are then placed in a vessel of cold water sufficiently large to cover them with water, and the water is heated until it comes to a boil, and this boiling is continued for three or four minutes. The bottles are then removed and placed on a clean, perforated surface (wire or punctured metal), mouth down, to cool and dry. The perforated surface on which the mouth rests permits the moisture on the inside of the bottle to escape. They are left standing in this position until they are filled for the day's use.

The size of the bottle depends upon the amount of milk to be given to the infant. The first feeding should be even less than an ounce, and the quantity of milk in the bottle may be increased very slightly day by day, and the amount of milk taken from the mother's breast correspondingly decreased. After two or three weeks of this gradual treatment the child may be entirely weaned. Both the child and the mother in this

way escape any discomfort, and the weaning becomes a process which is so gradual that the new style of life is entered without shock to either mother or child.

CHANGING FROM MILK FOOD

Next to the importance of weaning is the gradual introduction of the child to solid food. This must also be by degrees. It is possible by a careful study of the situation and proper manipulation to teach the child to eat solid or semi-solid food, diminishing to that extent the quantity of milk, until his quota of solid food is sufficiently large. The period at which this is to be accomplished cannot be arbitrarily fixed, but should depend upon the number of teeth the child has. As soon as the temporary molars are well developed, nature intends the child shall begin to chew. Learning to chew is a process which is mastered by the child himself. There is not much opportunity of teaching by precept or example. For this reason the first foods that are given should be semi-solid. There is nothing better for this purpose than a finely mashed fruit, vegetable, or cereal. Vegetables and fruits should be thoroughly cooked at this stage and passed through a

very fine colander. Children two years old will soon learn to like spinach, asparagus, potato, apple sauce, and foods of this kind, when given in this way.

These foods should be administered in small quantities, gradually increasing, but never to the extent of doing away with a very considerable quantity of the milk. The cereal I think the best for this purpose is wheat, not excluding, however, oats, maize, barley, and rice. There is a very great difference of opinions respecting the form in which these cereals should be administered to the child of two years and over. My convictions are rather strong on this subject, as I believe the demineralization of our cereal foods which is so commonly practiced is a threat to the proper growth and nutrition of the young child. The principal objection to giving whole cereals is based on the fact that the bran thereof may be irritating to the mucosa of the intestines. There is some basis for this opinion. If, however, the cereal be properly ground, so that the bran does not exist in large flakes but in small particles, no danger of irritation need be feared. I do not think it is advisable to grind cereals for the use of children on the common roller mill. The bran,

in these cases, is always very flaky. Cereals for children's use, and for grown people for that matter, are best ground on old-fashioned, well-sharpened buhr millstones. The bran coming from these millstones is very finely divided, and thus rendered incapable of mechanical irritation.

VALUE OF BRAN

It has also been objected to the feeding of cereals to young children that they do not digest the bran, that these particles are found practically undigested in the feces. There is also a basis of truth to this objection. It does not follow, however, that, because some particles of bran are not digested, injury has been inflicted. On the contrary, one of the very common defects of child nutrition is found in persistent constipation. Constipation does not threaten a child's life as diarrhea does, but the retention of the feces over twenty-four hours is detrimental. The feeding of whole-ground cereals is one of the best correctives of this fault. The quantity, of course, should be diminished if diarrhea or too frequent movements should supervene. The mother who is carefully watching her child's life and growth can easily determine this point.

QUANTITY OF FOOD FOR A CHILD

The quantity of food required for a child from two to four years old is important. Authorities differ in regard to the quantity, and well they may, because the same amount is not advisable for every child. As the weights of children from two to four years of age vary at the same age, so should, as a rule, the quantities of food which they ingest be varied. Below is given the table of Calories (energy and heat requirements) for children of given weights between the ages of two and four:

Weight, 28-32 pounds—Calories, 700-	900
“ 33-38 “ “	900-1,200

Children of these weights require from 80 to 70 Calories for each kilogram (2.2 pounds) of weight. Example: A child weighs 18 kilograms (40 pounds). Energy requirement = $18 \times 70 = 1,260$ Calories.

I have already spoken of the inadvisability of forming an artificial desire for sweets in the young child. I am not so set against this as to deny the value of sugar as a food. Its utility, and even necessity, are well known. My objection to

the use of added sugar to a child's diet rests on entirely different grounds. While sugar is a food, it is a dynamic food. It produces heat and energy almost exclusively. These are important things in the life of every human being, and especially in growing children. But sugar, starch, and oil (fat), while they have important and necessary functions in nutrition, afford nothing to supply or restore worn-out tissues. The child needs a full supply of nitrogen-containing foods and mineral-containing foods, out of which all the tissues of the body, with the exception of fat, are elaborated. While the infant and the child live on milk, they have a balanced ration containing all the necessary elements of nutrition in proper proportions for all the tissues of the body. The bones, the hair, the skin, the teeth, the muscles, the nerves, and the glands, all draw from this common stream the elements necessary for their up-building and sustenance.

IMPORTANCE OF MINERALS TO CHILDREN

As the milk is removed from the child's diet gradually when his teeth are developed and he can chew solid or semi-solid foods, the customs of this and other countries have endangered the normal

growth of the child by removing, especially, the mineral constituents of foods, which are so important. The child, by reason of the deficiency of his digestive organs, is supposed to be incapable of eating any of the skins of vegetables or fruits or cereals. It is in these skins that these mineral elements chiefly reside, and hence the necessary or supposed necessary elimination of them is calculated to diminish the amount of mineral matter at the disposal of the organism. I do not deny that the skins in large flakes are undesirable in infants' foods. If the skins of vegetables and fruits and cereals cannot be reduced to an almost impalpable powder, they are not suitable for introduction into the child's digestive organism. The cereals, especially, suffer from this almost universal habit of removing mineral ingredients.

DANGER OF SUGARS

If, in addition to this diminution of mineral substances, the foods are largely composed of added sugars, the damage is all the greater. Specifically, the addition of sugars to the diet threatens the welfare of the teeth as well as of the other tissues of the body. It is highly important that the development of the teeth of the in-

fant and young child be safeguarded. If we do not get good teeth by the time we are twelve years of age, we probably will never have them. It is not only for the day that we are building, but for all future time, when we tamper with the natural diet of the child and lay the foundations of an early decay and loss of his teeth. We not only threaten him day by day, but we injure him for the years of his activity yet to come. There is no more pathetic sight than to see one arrive at the age of young manhood or womanhood with a set of teeth helplessly decayed and useless. Good, plain, whole foods, such as I advocate, will do much to guard against these disasters.

If I were trying to standardize the forces which make for good teeth, I would not by any means seek to belittle cleanliness, but I would magnify nutrition. Unless we have good, sound teeth, built of the right material, cleanliness is of little avail to prevent decay. I should say, just at a rough venture, that three-fourths of the factors of good teeth are nutrition and only one-fourth cleanliness. At least twice a week the mouth of every child should be examined by his parent to see if there be any incipient decay. Once or twice a year the child should be carried to the dentist,

who should explore the hidden recesses of spaces between the teeth and see whether or not there be any need of professional attention. This, with the proper cleaning of the teeth, which the child can soon be taught, coupled with the proper nutrition, will bring all our children to manhood and womanhood with perfect teeth, which, if cared for in the future, will last them to a green old age.

MEAT IN A CHILD'S DIET

In regard to the use of meat, I am not a teetotaler, but a temperance man. I am perhaps extraordinarily temperate. I agree with Dr. Lorand when he says that the digestive organisms of the young child are not fitted for the care of the end products of meat digestion. In animal foods for children I am a great believer, especially milk, and, where there is no idiosyncrasy, a coddled or poached egg. There are many children who are sensitive to egg. A very little of it makes them ill. Children do not crave flesh foods unless, as is the case with sugar, their taste is excited by use. A little bit of fresh chicken, a bit of fish once a week, will probably be sufficient for all necessary meat uses in the development of the child between the ages of two and four. Meat

has, in my opinion, an important and specific use in the nutrition of man, but the inception of its use should be deferred for several years. Experience has shown that man may live his entire mature life on a vegetable diet apparently, and yet we know that in his early life, at least, and probably during his whole life, he eats animal products, such as milk, meat, and eggs. My plea, however, is for the child. I believe he is better off, at least until he is four years of age, with little or no meat.

FREQUENCY OF FEEDING

The frequency of feeding a child should rapidly diminish after infancy. The child from two to four may possibly have four meals a day, from two to three especially, but he may soon be taught to do with three. The constant nibbling at biscuit, zwieback, or fruits, or other foods, between meals should be early discouraged. In fact, it should never be begun. Children naturally like to be eating; but it is no mark of affection to the child to yield to its every desire. In fact, one of the greatest enemies of child-life is the mother's love. Her tender heart cannot resist the plaintive appeal of her young. Without thought of whether

it is good or bad, she gives the child what he wants. This application of parental affection must be carefully curbed. We cannot have the proper nutrition of the young child if its parents' love leads to an indulgence in his every whim. There is no reason why even the child of three years of age may not be firmly grounded in the principle that he should eat what is good for him. There is no reason why every child may not even reprove his parents, as mine has done, for offering him things which he has been taught to believe are injurious. We fail to comprehend the teachableness of the infant and the young child. The teacher's work begins the day of the child's birth and never ceases until the old man of eighty-five or ninety is carried to his grave. The time which is spent in coddling children, in yielding to their whims, in foolish baby-talk, might well be devoted to serious instruction. The child likes it better than he does nonsense. He becomes speedily interested, before he can speak, in serious words spoken to him and in everything pointed out to him, the beauties of nature, and the trees and brooks, the mountains and the forests. We wait too long to begin the education of our children.

LESSON XVI

THE FEEDING OF CHILDREN BETWEEN FOUR AND TEN YEARS OF AGE

THE child at four has developed his temporary teeth, but has still a serious trial to undergo in their loss and the development of the permanent teeth. Of great significance is the care of the temporary teeth. Soon after the age of four the growth of the permanent teeth begins to increase in vigor, and the pressure which they exert upon the roots of the temporary teeth causes them to absorb until gradually the temporary tooth is so far undermined that it comes away of itself or as the result of slight traction. This is the natural and proper way to get rid of the temporary tooth. The canal through which the permanent tooth emerges is thus kept solely for its own use. If a temporary tooth decays or is lost before its time, not only will the permanent tooth which belongs to its place seek to emerge therefrom, but each of the buds of the permanent teeth

on either side will endeavor to follow the line of least resistance. The result is, therefore, deformity, often of a serious character. If the temporary teeth begin to decay at any period before the time of their natural disappearance, this decay should be combated as if it were a permanent tooth, in order to avoid the misfortunes of distortion and malformation of the buccal cavity.

From the periods of five to ten food should be so chosen as to make it possible for the child to masticate his foods with the impaired apparatus which is then at his disposal. Incisors are the first of the temporary teeth to disappear. Foods that are hard to bite are, therefore, to be discouraged during this period. At the same time the molars are still operative, and it would be unfortunate if no food which requires mastication should be taken. This difficulty is avoided by offering the hard foods in small pieces, so that they do not have to be separated by the incisors, but are still capable of furnishing activity to the molars. Hard bread, biscuit, tough vegetables, fruits, and things of that kind, during this period, are to be cut into small pieces, so as to avoid giving unnecessary or perhaps impossible labor to

the incisors. By the seventh or eighth year the permanent incisors are fully developed, or at least sufficiently so to again perform their functions and separate the harder foods into lumps of convenient size for mastication. At this period the chewing capacity of the child is restored, at least until the temporary molars are ready to disappear. Thus the physical state of the food becomes a matter of grave importance during the ages from five to ten.

CHARACTER OF FOOD OF OLDER CHILDREN

In regard to the character of the food of the child at this age, little need be said in addition to that which has already been developed. Breads and mush made from whole cereals and pure, wholesome milk should continue to be the basis of nutrition. The child may now be inducted into the use of small quantities of meat, and by this I mean flesh foods in general; namely, that which is usually called meat, fowl, and fish. The child's digestive functions are still sensitive to foods that are *passé*, or, as it is usually expressed, to ptomaine poisoning, whatever that may include, and during this period of child-life the colic and its attendant diarrhea may be ex-

pected in children whose foods are not carefully controlled. The child has not yet acquired the sense of responsibility as to his diet, and hence is apt to overeat whenever he has access to anything which he likes. Nausea, vomiting, and diarrhea are not unusual sequelæ of these faults of diet.

DANGERS OF CODDLING

The child cannot always be watched. He must be left to himself for the purpose of developing individuality and character. While I advocate careful control of the child's diet and conduct, I am far from thinking he should spend every moment of his time under the eyes of his nurse, his mother, or his tutor. Self-confidence, individuality, and character are rapidly formed during this period. The watched and coddled child is apt to become a being described rather indefinitely, but still distinctly, by the term "mollycoddle." We used to say that such a child was tied to his mother's apron-string, that he was a "sissy." Other expressions of a similar character are used to designate the overwatched and overfondled child. The parent is to steer a middle ground in this case, developing, on the one hand, indi-

viduality and character, and, on the other, warding off dangers which are, alas! too often fatal.

QUANTITY OF MEAT FOR CHILDREN FIVE AND TEN

The quantity of meat which the child between five and ten should use is not very great. It may be increased little by little until the tenth year. Even at ten the child should have only a small fraction of the meat which an adult consumes. It is difficult to specify any particular amount or kind, as such a specification would fit only one particular class. A better way is to have the parent watchful and considerate respecting the dictates of hygiene and health, on the one hand, and, on the other, consulting the tastes and likes and dislikes of his child in so far as that can be done without injury to health. If a child requires, say, from 1,200 to 1,400 Calories in his diet per day, it would be amply sufficient on an average that from 50 to 100 of them should come from meat, say 50 in the child at five and 100 in the child at ten. This quantity, in my opinion, would be an ample allowance, but should be varied according to the individual tendencies as outlined above.

Meat given the child at this period should be,

as a rule, fresh. Cured meats are better left for a later period of life. Canned meats, especially, should be avoided, in my opinion, for children, not that canned meats are not, as a rule, perfectly wholesome, but there is always a danger, perhaps a remote contingency, but, nevertheless, one which should not be overlooked, of some fault in the canned article which might pass without influence upon the adult, and yet which might seriously affect the child. By fresh meats I do not mean those immediately slaughtered, because, in my opinion, all meats, except fish and shellfish, are improved by being kept in a cool room until their natural heat has disappeared. In other words, the fresh chicken is better after hanging in a cool room for twenty-four hours than it is if cooked immediately after slaughter. Fish, unfortunately, are usually more than twenty-four hours old before they come to the table, and yet a fish is never so good as the moment at which it is taken, when it should be killed by cutting off its head and allowing its blood to escape. Beef is well known to be better after from three to five weeks' hanging in a cold room just above the freezing point. Pork, veal, and lamb are better hung for twenty-four hours or more in a cool room after slaughter.

All of these, however, even beef, that have been hanging for three weeks are recognized as fresh meat.

One meal a day, preferably the noon meal, should be the meat meal. Meats are more rapidly digested in the stomach than cereals, for the simple reason that the stomach digestive organisms are almost solely those that attack nitrogenous foods. The reason I recommend meat for the midday meal is that it is especially active in producing heat, not by reason of its composition so much as by some specific action the protein has upon metabolism. In other words, the system seems determined to burn all protein matter which is digested, whereas starch and sugars may be stored for a long while before they are burned. As the child is active during the day, and especially the afternoon, the meat at noon supplies the heat and energy which he consumes in play. Similar reasons would lead to the use of meat for breakfast, if not used in the midday meal. As the child is quiescent at night, it is better that no meat enter his diet for the evening meal.

CALORIE VALUE OF THE DIET

The quantity of food, measured by Calories, which a child from five to ten years of age needs is set forth in the following data :

Weight, 35-50 pounds—Calories, 1,200-1,400

“ 50-75 “ “ 1,400-1,800

Calories per kilogram of weight, 70-60. Example: Weight, 25 kilograms. Energy requirement = $25 \times 70 = 1,750$. Children who are very quiet will require less fuel, and those hard at play more than the numbers given.

The vigor of the child's physical activity increases rapidly during the age from five to ten. It is essentially the age of play and bodily exercise. It is also the age of the beginning of the growth in length. For this reason the child needs a greater amount of food according to his weight than the grown person, and this excess of food is used up in the vigor of play and in continued growth. During these ages, also, the child that has been properly trained as an infant and young child, and whose training is continued in the fundamentals of diet, will develop a character and habit which will be a guide to safety during the

rest of his life. Not only is he able to obey his parents' injunction not to eat those things which are injurious, but he will begin to understand the reasons why, and this will add strength to the firmness of his conviction.

TELL THE CHILD THE REASONS FOR HIS DIET

It is too early, perhaps, to begin to instruct the child seriously in the fundamentals of nutrition. This is indeed not necessary at this early age. It comes in a very proper place a little further on. But he can understand the reasons for specific exemptions in the matters of things eaten and the selection of others. He will also begin to understand the function of play, not simply to amuse, but the necessity of it to develop the strength of limb and brain. He will also understand what a major factor food is in connection with this development. Care should be exercised at this period to guard the child against the habit of eating candy and other sweets. The temptations to do so are much more frequent than at the earlier age, and often they are presented in the absence of his parents or guardians. The eating of large quantities of sugar, candy, and sweets not only interferes with normal growth and nutrition, but

especially tends to injure the quality of the permanent teeth which are making their appearance. We are not ready, even at ten, to open the doors to the flood of sugared foods. If it comes at all, it must be later in life.

DANGERS OF THE SCHOOL

During this period the child usually begins to attend the public school. Here he is obnoxious to a whole army of dangers from which he is practically free at home. Bad air, infection, and bad company are to be expected in a public school. Everybody may go to a public school, and thus the unfortunate circumstance arises where the child is brought into contact with a small number of bad units whose influence is often disastrous. Among the bad influences to which he would be subjected is the habit of eating sweets of all kinds, cakes, and so forth, which is so largely practiced by school children. Cheap candy stores have a great vogue near the large public-school building. The package of candy that can be had for a penny is greatly in demand, and these booths are frequented by the school children during the hours of intermission, with pennies which unfortunately

their parents have given them without a warning as to how they shall be spent.

IMPORTANCE OF SCHOOL LUNCH

The midday lunch at school is a matter which the parent should consider most seriously. It is here that the little sandwich which contains some good meat does its best work. I do not share the general prejudice against so-called cold foods, meaning foods at the ordinary temperature of the room. It is extremely inconvenient to provide a hot lunch for the child at school, unless the school building be furnished with a kitchen. The parent will look forward to the luncheon at the ordinary room temperature as the condition which usually obtains. A sandwich made out of brown bread and butter, or with a little piece of cold beef or cold chicken, or with a lettuce leaf and a little mayonnaise or other dressing upon it, is to be regarded as the basis of the school-day lunch. If the school building contains a refrigerator, where a bottle of milk can be kept at a low temperature, so as to avoid the development of micro-organisms, it is advisable to provide the child with that ration; but this is usually not available, and the luncheon, therefore, may be faced with the idea

of excluding milk. Coffee, tea, or chocolate is out of the question for luncheon purposes, or, in fact, for any purpose connected with the nourishment of the child. Fruits lend themselves remarkably well to luncheon purposes. An orange or an apple is easily transported and is appetizing and wholesome. I do not recommend so highly bananas, though, of course, in moderation the banana is a wholesome enough diet. It is too preponderantly carbohydrate. It does not have the acid principles of the orange and the apple, and, therefore, I do not regard it as so wholesome an article of diet. Desserts, in my opinion, should be excluded from the child's school lunch. Neither cake nor pie is desirable. The luncheon should be simple. The whole cereal bread sandwich of some kind, the glass of milk, and the orange or the apple should be regarded as the ideal for this meal.

INFLUENCE OF FOOD ON DEPARTMENT AND PROGRESS

Experience has shown that children who are not well nourished either at home or at school are backward in their studies, inattentive, and often mischievous. In those localities where the public spirit or the enlightened philanthropy of the citizens or the school committee has provided for a

hot lunch, it has been found that the sandwich with a piece of roast beef produces the ideal results. Those children who are not able to bring wholesome food to school are vastly benefited by an arrangement of this kind. The study of the breakfast basket of the school child throughout the country has revealed a woful state of ignorance of the parents regarding the principles of nutrition, or else a lamentable lack of means to secure the proper diet. The hastily baked, so-called biscuit, a pickle, or a piece of sad pie, are too often found in the armament of the midday meal. The success of the child at school depends not alone upon the teacher, nor the curriculum, nor the school-book—it depends most of all upon the nourishment of the child.

LESSON XVII

THE FOOD OF THE CHILD FROM TEN TO SEVENTEEN

WE have one further step in the study of the proper food for growing children; namely, from ten years of age until they reach the status of maturity, at least in so far as nutrition is concerned. From ten to seventeen years of age is a critical period in the history of early childhood. During this period both physical and mental growth are extremely rapid, and the bent is given to the character which determines practically the conduct of future life. The real man or woman is in the making particularly during this period.

First of all, the fact must be kept in view that the digestive organs at the beginning of the tenth year have approximately reached development. There is little difference in the nutritional processes of the child of ten and the mature man of twenty-five, yet there is a progressive scale indicative of the passing years. For equal weights the

child during this period still needs a larger amount of food than the grown person. Not only is this an age of great physical and mental activity, thus requiring an abundant source of heat and energy, but it is also an age when new tissues are constantly added to the old, thus demanding an increased supply of body-building materials. An important crisis in the life of the child takes place during this period in the advent of puberty. Especially with girls at this period there are often developed abnormal tastes and desires for the eating of things which are anything but wholesome. This is the era of chalk, lead pencils, and pickles for the budding girl. The effect of puberty on the boy is not nearly so marked as on the girl, but, nevertheless, it is most important.

FOOD NUTRITIONAL AND NOT STIMULATIVE

The food of this period should be nutritional in every sense of the word, and not stimulative. The new life to which the child awakens in this period is of itself sufficiently stimulating without any adventitious help. There is no period of life when stimulating and exciting foods should be so carefully avoided as during this period. Unfortunately, also, this is the period of life in which

habits of diet are contracted that are likely, if of an improper kind, to prove of immediate and lasting injury. In the case of the boy, especially, the temptation to use tobacco and alcohol is presented in most attractive forms, and it requires the careful oversight of the parent or guardian and the proper instruction and firmness of will of the child to safeguard him through these threatening conditions. The literature to which the child has access is quite as important as the food at this period. Erotic novels, stories of hairbreadth escapes, and the whole realm of yellow literature, are to be excluded from the life of the child during this period, as well as exciting, stimulating, and improper foods, and ill-chosen moving pictures.

CANDIES AND CONFECTIONS

Some of the things which are not permissible before the age of ten may now be indulged in without immediate danger. A moderate amount of sweets may be introduced into the child's diet to help furnish the heat and energy for his active life. I do not advise this. I think it better that normal foods with only the amount of sugar which they naturally contain should be used, but I realize that the mode of life to which we are subjected in

this country must be taken into consideration in a study of this kind. The universal use of sweets is sufficient excuse for studying to determine, if possible, what are the safe limits of toleration. It is not so much the sugar which these bodies contain as it is their appetizing quality. Unfortunately, in our system of eating, the dessert, which usually contains the sweets, is given after a meal which in itself is entirely sufficient for the needs of the body. The result is that the system is overloaded with food-forming material. Not only is this so, but these bodies have such a pleasing taste that we crave more and more of them. I need only refer to the experience of everyone to whom palatable candy is offered. He is not satisfied with one or two small pieces, but the tendency always is to continue eating until we are gorged. This is the great danger of the introducing of sweets, especially of candies, into the diet of the young. Worse than this, candy, especially, is not so much eaten at meals as it is between meals, thus threatening the digestion with a new danger of disturbing its process by asking it to begin all over again on a new supply. I earnestly recommend, therefore, that sweets be indulged in most temperately, and, if possible, in

such a way as to prevent the formation of the habit.

MEAT A CONSTITUENT OF THE DIET

The addition of meat to the diet may now be regarded as proper. The quantity eaten, however, should not be as large in proportion to the whole diet as in the mature person. If the Calories requirement per day in the child of ten to seventeen runs from 1,200 to 2,000, I should say that 10 per cent. of the total Calories to be derived from meat is amply sufficient. This would give 120 Calories arising from meat for a child ten years old, and 200 Calories arising from meat for the child seventeen years old. I am aware of the difficulty of fixing any hard and fast limits for matters of this kind. I am only suggesting what to me seems a fair mean amount. There are some children who are extremely fond of meat, and they might have a little more; others who do not care so much for it, and they should have less. If a child does not like meat, I would strongly advise against teaching him the meat-habit. His natural instincts are probably a better guide in this respect than the judgment of his parents.

The ages which we are now considering are

the scholastic ages, that is, preparatory to collegiate and university studies. The importance of diet to the child in the public school or in the high school is of great interest to his progress in his studies. Overeating, especially before going to school, is highly objectionable because of the burden it places upon the digestive tract, depriving the brain of its fair supply of blood by reason of the excitation of the digestive organs. It is difficult to fix one's mind on a study and to get the benefit that should come from it in a condition of this kind. On the other hand, deficient nutrition works in equally as disastrous a way. The middle ground is the safe one—an abundance of pure, simple food, which, however, should not be taken principally at breakfast, nor at noon, but in the evening after the school-work is done.

DANGERS IN TEA AND COFFEE

The use of tea, coffee, and chocolate, of soft drinks of a practically harmless character, and of so-called soft drinks containing an added alkalioid, is to be avoided with the utmost care. The soda fountain is an attractive place for the child. The attraction of it consists chiefly in the sweetness of the syrups used, and not so much in the

bitter flavoring matters which soft drinks so often contain. The soda-waters are supplied ice-cold, as a rule, and this chilling of the stomach is bad, not only for the grown person, but especially for the child. I would discourage, in so far as possible, the frequenting of soda fountains by children under the age of seventeen. No one knows just what kind of material you are going to get. Even the ethical druggist who operates the soda fountain is not always informed as to the nature of the materials he is dispensing. The gathering of children about the soda fountain does not speak well for their health nor for excellence in their studies.

Experience has shown that the drinking of tea and coffee is extremely detrimental to children, and especially does it interfere with the progress in their studies. It is true that the caffein which tea and coffee contain and the theobromin and caffein of cocoa and chocolate stimulate in a certain way the mental faculties. That they build up or strengthen these faculties no one claims. It is a wholly artificial stimulation, entirely different from that of normal nutrition, and can be looked upon in the light of scientific investigation only as eventually leading to injury. A study of

the size and health of children and their progress in their studies as between those who drink coffee and those who do not drink coffee has been uniformly favorable to the non-drinkers. The parent who permits his boy or girl to form the habit of coffee, tea, or chocolate drinking is unwittingly standing sponsor for future ill health and inefficiency.

THE SMOKING HABIT

Smoking is now becoming fashionable among women, and there is no reason to believe that in the near future we may not have a threat to our girls in the way of cigarette-smoking such as has been presented to our boys for many years. So disastrous is the effect of smoking on children that many states forbid the sale or giving away of cigarettes to minors, and others place the use of these materials under strict restrictions. The best way of all is to place a ban upon it absolutely at the home. Teach boys and girls the danger of the habit. Show them its uselessness and extravagance. Let them learn that it means for them deficient mental and physical ability. Supplement this instruction by such regulatory acts as will place a ban upon dispensing cigarettes

or tobacco in any form to minors. In this way the evil will be avoided. There is no more pitiable sight to me than to see a boy of ten to seventeen smoking a cigarette. I at once lose faith in his future. I see in his development only an inefficient and perhaps invalid citizen.

AVOID A MONO-DIET

The diet of the child between ten and seventeen is to be sufficiently expansive to introduce a variety of foods which will prevent any bad effects from a mono-diet. Well-made bread from whole wheat contains practically all of the elements which nourish the human body, and yet our motto is "Not By Bread Alone." The whole-wheat bread should be the basic diet of the child. If a beverage is to be used, and I advise its use during these ages, pure, clean, wholesome milk is the one to be selected. It is not so important that the percentage of milk in the diet at this age should be as great as that in the earlier ages of childhood. It is largely a matter of opportunity and taste. It is expensive to supply the right kind of milk to a large family. If any economy in this matter is to be exercised, it should be for the protection of the infants and younger members of

the family. With the exception of milk I would not advise the use of any beverages during the meal. Experiments have shown that the use of water at mealtime is by no means injurious, although the earlier physiologists taught us that it was. It undoubtedly tends to diminish the excretion of saliva, and hence I believe that it is better to eat our meal with no beverage except milk and to drink the water afterwards. No harm will come, usually, from diluting to this extent the contents of the stomach.

IMPORTANCE OF WHOLE FOODS

The proportion of whole foods for the child of this age should be as great as possible. The whole cereals, potatoes with the skins, and raw apples with the skins or baked apples with the skins, and vegetables that, if boiled, are boiled dry, so that extracted salts may be re-absorbed, are highly advisable. This is the age when mineral starvation should be rigidly excluded. The bones, especially, need plenty of nourishment during this period, and also the mineral elements which enter into the bones—namely, phosphoric acid and lime—have important functions in other tissues of the body. The diet should be so regulated that constipation

is entirely avoided. While it is possible to live in a state of health with only one evacuation of the bowels a day, two ought to be recommended. The best periods for this are early in the morning and late at night. The diet should be especially regulated so that the child does not take on any unnecessary fat.

DANGERS OF ALCOHOL

It is probably unnecessary to give a warning respecting the use of alcohol. Happily, in most instances the children of our country today are brought up in a manner whereby the danger of forming the alcohol-habit is practically eliminated. There are few parents at the present time who give their children alcoholic beverages of any description as a part of their diet. I doubt if there are any parents of American birth who do this. Among our citizens born abroad there may yet be cases where beer and wine are a regular part of the child's diet, but these cases are not the rule. I have often heard it urged that the safer plan to avoid drunkenness in mature years is to be accustomed to the use of alcoholic beverages as a child. The facts on which this statement is based are found in the general condition

of the people in wine- and beer-drinking countries. In Italy, Germany, and France drunkenness among grown persons is not nearly so common as in England and in the United States. I do not see the pertinence of the argument. It is not because our children are brought up without alcoholic beverages that some of them use these beverages in excess afterwards. It is the habit of life in our country. Conviviality is of a more special, though perhaps no more general, kind than in other countries, but, unfortunately, our idea of conviviality is too often based upon the quantity of alcoholic beverages consumed. In other words, the American youth, if tempted to use alcohol, is apt to be in a company where it is used to excess, whereas the child that is taught to use alcohol at home, in France and Germany, is taught to use it in moderation. I cannot see any direct relation between strict sobriety in youth and inebriety in mature age. I prefer, therefore, in the case of my own children, to be as careful as possible to protect them against forming the habit of consuming alcoholic beverages in youth.

EFFECT ON HEALTH AND MORALITY

I do not intend here to go into a discussion of the effects of alcohol upon health, upon mentality, and upon morality. One needs only to search the records of our criminal courts to find how often the intemperate use of alcoholic beverages is the incidental cause of crime. It is a common belief among experts that the excessive use of alcohol by the parent tends to cause degeneracy and oversensibility to disease in the offspring. The records compiled by the life-insurance companies indicate that heavy drinkers, and even moderate drinkers, do not have expectation of as long a life as those who are temperate or total abstainers. These are facts which are based upon statistics believed to be reliable. I am not ignorant of the fact that often men who have been addicted to the use of alcoholic beverages, even to some excess, have lived to a green old age. The same is true of those who use excessive quantities of coffee and tobacco. I am convinced, however, that the general effect of alcoholic beverages is bad. It tends to make its users more subject to disease, more likely to perform criminal acts, and less likely to live to a green old age. The protec-

tion of our civilization, in my mind, rests largely upon rigid control, or even suppression, of the traffic in alcoholic beverages.

CARE IN THE USE OF CONDIMENTS

Children between the ages of ten and seventeen should avoid the use of difficultly digestible or highly spiced foods. The pickle, the oversalted meat, the too abundant use of pepper and other condiments are not to be recommended even for grown people, and certainly they are not good for the young. The simpler the diet, the truer to nature, the more complete in affording all the elements which the natural foods contain, the better for the boy or girl. The quantities of foods which, upon the average, are to be consumed by children from ten to seventeen years of age are found in the following table:

Weight, 60-	90 lbs.—	Calories per diem, 1,400-2,000
“	90-110 “	“ “ “ 2,000-2,800

Calories per kilogram of weight, 65-55. Examples: Weight, 30 kilograms. $30 \times 60 = 1,800$ Calories. Weight, 50 kilograms. $50 \times 55 = 2,750$ Calories.

LESSON XVIII

A LARGE CROP OF CHILDREN'S DIETARIES

THE question of proper food for infants and children is of perennial interest. One authority after another utters the dictum which, from his point of view, settles the matter. The trouble is that the dicta are contradictory. I have already given my own ideas in regard to this problem. It is only fair that I should tell why I object to many popular practices in choosing the child's diet. No wonder the intelligent mother finds herself in a hopeless maze in seeking the right path for her child's diet. The woman's journals and new books are constantly pouring not always a flood of light, but a flood of material upon the problem. All have their menus for budding men and women from the age of one day to eighteen years. A late number of a woman's magazine gives twenty-one menus for a week's feeding of a normal, healthy child after the third year, which is truly formidable in its number of

items, and at times wonderful in variety and composition. One meal is as follows:

Dinner—Lamb stew with vegetables; baked spaghetti; white bread and butter; lettuce, French dressing (use few drops lemon juice with oil); baked custard.

When it is considered that the same child has two other meals for that day, each with different kinds of foods, and the same variety for the other six days, we are certain at least that children thus fed will not suffer from a mono-diet.

BEER AS FOOD FOR A CHILD

Lately there has been injected into the area a propaganda to show that beer is a much better food than milk! A sustained effort has been made to drive milk out of its trenches. It has been urged that milk and beer are alike in raw materials, methods of manufacture, and composition, and should have similar standards. Eminent authorities are cited to show the excellence of beer and the deadliness of milk. "Beer is liquid bread"; "Beer has the food value of milk"; "Beer must be regarded as a veritable food product"; "Alcoholic fermentation is a phenomenon

correlative with life"; "Alcohol is a food because it yields energy, though it does not build tissue"; "Relatively, milk is too rich in protein and too poor in carbohydrates to be a perfect food"; "There is no article of human diet so much under suspicion, hygienically, as milk," etc., etc., show the plan of the campaign.

All this looks quite formidable. These learned men have been talking about one thing, and now the beer propagandists are trying to make them sponsors for quite a different thing. The trouble comes from confusing fuel value with nutritional worth. Alcohol has a higher fuel value than any class of foods except fats. The carbohydrates, proteins, alcohol, and fats are relatively classed as to fuel value by the numerals 4, 4, 7, 9. It doesn't follow that beer is good for children. In point of fact, I think it highly injurious. The burden of getting rid of the toxic alcohol just as soon as possible, by burning and excretion, more than offsets any value it has for supplying heat and energy. As a food, milk is as unlike beer as Dr. Jekyll is unlike Mr. Hyde.

What are we going to do in the midst of all this confusion? Paul says, "Prove all things; hold fast that which is good." Happily for his

reputation, he wrote that phrase before children's diet became a subject of discussion. He, indeed, would have a Herculean task set for a life rivaling that of Methuselah if he should attempt to "prove all things" claimed for children's foods and dietaries. Moreover, the child's life is too precious to become a subject of proving. We had better do the "proving" on mice and guinea pigs.

Happily, there are some things that need no proving. One is that clean milk, fresh and pure, is the ideal food of the infant, and, for many years after infancy, of the child. Second, we know that the infant's digestive tract is not adapted to the digestion of starch and meat. And, third, we know that the digestive organs of young childhood from two to six cannot adequately handle animal foods other than milk, and perhaps eggs.

When I look over a child's diet, as I have just done, and find recommended for children over three, well-cooked farina, hamburg steak, roast beef, molasses cake, chocolate, cornstarch, and lady-fingers, I am at my wits' end. Being favorable as I am to meat as a part of human diet, I cannot bring myself to the belief that any considerable quantity of it should be used in the early

years of the child's life. After he is ten or more, meat may become a regular article of diet, but not before. As for white bread, cornstarch, farina, and polished-rice pudding, I am quite convinced that these things had better be left out.

The child's diet should be simple and confined to the fewest articles necessary to secure proper variety. Fruit, whole cereals, well-baked bread from whole cereals, milk, butter, and vegetables, especially spinach, asparagus, roast potato (eaten with the skins), beans and peas, whole fruit, and baked apple will give the child a proper basic diet. Soft-boiled egg, a small piece of the white of the chicken once a week, a bite of fresh fish on Friday morning, and possibly a taste of roast beef or lamb chops once or twice during the week, are entirely sufficient, as far as meat is concerned.

IMPRACTICABLE TO PRESCRIBE A DEFINITE DIET

To prescribe for a child a definite diet which is invariable would be the height of folly. Among the basic foods which I have mentioned there is a variety sufficient to supply the needs of practically every normal child. An excess of starch and of sugar is as carefully to be avoided as an

excess of meat. We want a child to grow, not to fatten. It is muscle and bone, and not adipose tissue, that we need to create. The apparent rotundity of infants and children fed on modified starches, which represent the great majority of so-called infants' foods, is illusory and deceptive. These children are not healthy; they are fat. They are probably among the least resistant to the inroads of diseases which are so fatal to child-life.

These products of the hydrolysis of starch have also quite a vogue as milk-modifiers. The makers realize the bold mercenary character of the attempt to substitute them bodily for milk. But why should good milk be modified other than by the addition of water and milk-sugar? Does the physiological knowledge of the maker of infants' food excel that of the Creator? Largely, this business is based on the fact that bad milk is so generally administered to infants and young children. The more you mix such milk with other neutral bodies, the less dangerous it becomes. Many doctors advise the use of barley flour, dextrose, maltose, and even cane sugar, in cases where the infant already has diarrhea and incipient starvation. Even these unnatural foods are bet-

ter than bad milk. But for the healthy child who can get pure milk they have no warrant.

When the "doctors" prescribe such a wonderful variety of diet for a child, hesitate before putting the precept into practice. Remember the gospel of simplicity that I am trying to preach. A simple diet of wholesome foods is what the child needs for its proper development. Begin early. Avoid the possibility of forming the "sugar-habit." I was proud, only yesterday, at a gathering of grown people and children, where cake was served, to have my three-year-old son come running to me when the cake was brought out, crying out in great joy, "Daddy, I won't eat that cake; it isn't good for me." Only a few days before this his mother, hearing the noise of a battle in the front yard, ran to the window and saw the young dietitian astride the prostrate form of Dickey, his even-aged playmate, administering an assorted variety of Jess Willard "knock-out drops." "What are you doing, Harvey?" she cried. "Dickey *will* eat candy, and it isn't good for him," was the response. Shall we have to come to militant methods to save the health and teeth of our children?

USE OF EGGS

In regard to the use of eggs, which is so uniformly recommended as an effective method of administering animal protein to infants and growing children, too little attention has been paid to the fact that many children are oversensitive to the influence of eggs. In the establishment of that condition of the body which is known as anaphylaxis, that is, extraordinary sensibility to the poisonous effects of foods, too little attention has been paid to the fact that children may frequently exhibit this peculiarity.

A case in point has lately been brought to my attention. A child in Boston who had just completed his third year gave evidences of some dietetic disturbance resulting particularly in a bad breath, paleness, and lack of activity for one of his age. The mother was greatly concerned in regard to this matter, and, among others, consulted me regarding it. She submitted to me a list of the articles of food which the child was eating, which, measured by the ordinary standards, was fully sufficient for the child's perfect nourishment. Among these articles of diet egg was mentioned as being frequently administered. Knowing

that at this age egg was a very common diet recommended by competent experts for children, I failed to find any part of the menu which could be scientifically criticised. It is rather a hopeless task, anyway, to give any valuable opinion in a case of this kind *in absentia*, and so it was with considerable regret that I was compelled to write to the child's mother that I did not see anything at all wrong with the diet on which the child was nourished. Soon after that the mother happened to see in a newspaper an account of a child who had suffered very much in the way of ill health, and when the egg was taken away from his diet the annoying symptoms and the disease itself from which the child was suffering soon passed away. Acting on this hint, she took the egg out of the diet of her child. The result was most striking. Immediately the child began to improve. In a very short time the bad odor of his breath disappeared, and the conditions of complete health and physical activity speedily returned.

In the case of my own son, we have never had any success in giving him egg. It doesn't agree with him. He doesn't like it, and he is evidently supersensitive to its effects. There may be simi-

lar oversensibilities to other forms of animal protein. Parents are, therefore, urged to be extremely observant of the effects of the administration of animal protein to their young children, and if any peculiarity of conduct or any variation from a state of health results it is advisable to withhold at least one of the proteins, and maybe all of them, one by one, until it is possible to discover which one is causing the trouble.

THEORETICAL VALUE OF ANIMAL PROTEINS

Theoretically, it would seem that animal protein would be more suitable than vegetable for animal nourishment. Let us recall for a moment that in the process of digestion all proteins are entirely broken up, so that they enter the bloodstream in very primitive and simple forms of combination. From this simple form they are built up into various proteins of the new organization. Apparently animal proteins would lend themselves best to the synthesis of this kind, because they contain the building-stones of animal tissues. If this supposition were true, then the cannibal would have the purest food of any human beings, inasmuch as he eats that character of food represented by his own body which he wishes to nour-

ish. In point of fact, scientific investigations do not support a contention of this kind. Were it true, the great body of animals that feed upon plants would be at a decided disadvantage in comparison with the meat-eating animals of the jungle. The data which we have in regard to the comparative vitality, the length of life, and the amount of service which different animals may furnish, do not bear out any such supposition.

COMPARATIVE VALUE OF MEATS OF DIFFERENT ANIMALS

Many contradictory statements confront the person who wishes to get the truth respecting the differences in the value of the meat of different animals. A great many authors give dogmatic statements as to what should be and should not be eaten. None of these statements seem to rest on truly scientific foundations. The Mosaic dispensation provided certain rules to guide the consumers of meat. The fundamental rule in the hygienic code of Moses is that man should eat the flesh of those animals that have cloven hoofs and chew the cud. The range of animals suitable for human food is very greatly restricted by this provision. Experience has shown that there is no

animal food, in so far as any scientific reason is known, that is in itself specifically inhibited. Grasshoppers, snakes, toads, eels, wild game of almost every description, practically every kind of fish, with all kinds of domesticated animals, including cats and dogs, have served for human food. There is a distinct difference, however, in the flavor of these foods. We exercise, in other words, ideas of cleanliness, and the sense of taste and smell in selecting our foods, and are no longer guided by the cloven hoof and the chewing of the cud.

Esthetically, animals of the cleanest habits are preferred for food. Yet the hog, who is condemned to live, usually, in squalor, is perhaps the most generally eaten animal of the world. The hog, however, is, in point of fact, an animal of excellent taste and discrimination, and if he had opportunity would probably be the most cleanly of the farm animals. He is more careful of his bed and table by far, if he has the opportunity, from a sanitary point of view, than is the sheep or the ox. Animal foods that are tender, that have a good taste and a pleasant odor, may be regarded as suitable for foods. At the same time it would be useless to attempt to eradicate a

prejudice, and it may be well founded, against animals that eat decayed flesh or live by preference in insanitary surroundings. The flesh of the vulture or the buzzard will never be preferred to that of the chicken or the turkey. One will not choose a steak of the hyena when he can have a cut from a full-blooded Aberdeen Angus steer.

LESSON XIX

THE RELATIONS OF GOOD TEETH TO NUTRITION

MODERN methods of the preparation of food and of feeding have robbed the teeth of much of their normal activity. All unnecessary grinding or pulping of foods before they are eaten tends to interfere with the normal functional activity of the teeth. Nature develops the teeth at a period of life when milk ceases to be the sole food required and solid foods of various descriptions are beginning to be used. The deplorable condition of the teeth of the children of the country, and consequently of the grown people, is not commonly known. The investigations which have been made into the character of the food eaten by our school children have been supplemented by an investigation of the character of the teeth which are called upon to masticate these foods. The revelations of the latter investigation are quite as terrorizing as the first. The percentage of children of school age that have irre-

proachable teeth is extremely small. Investigations have shown that 60 to 90 per cent. of the children in our public schools have defective teeth, running from the merest beginning of decay to the worst forms of irregularity and disease. A very considerable proportion of the children, probably 10 per cent., could not be well nourished even if they had an abundant supply of the best kinds of food.

Not only do bad teeth interfere with the normal processes of chewing, but they go a great deal farther than this, and threaten the general health. Any focus of infection, wherever it may be, in the teeth, in the tonsils, in the lungs, or in other vital organs, does more than local injury, because of its intimate relations with the circulatory system and the possibilities of carrying the poison resulting from the local infection to all parts of the body. As a means of maintaining health and promoting growth good teeth are of supreme importance. I have treated this matter at some length in my presidential address before the National Mouth Hygiene Association, delivered in conjunction with the American Public Health Association meeting in Jacksonville, in December, 1914, a synopsis of which follows: ¹

¹ *American Journal of Public Health*, Vol. 5, No. 5, p. 412.

MOUTH HYGIENE NOT A NEW STUDY

The hygiene of the mouth is not a new study. It has been generally recognized for many years as an important adjunct to the hygiene of the body. It is only of recent years, however, that the study of mouth hygiene has assumed the dignity of a separate branch of public health activity. In the general oversight of the public health, the medical profession of the United States has taken the initiative and leading part. In the organization of mouth hygiene as a distinct branch of the public service, the dental profession of the United States has taken the initiative, and is expected to assume the leading rôle.

BAD TEETH A MENACE TO HEALTH

Lack of care of the mouth and its appendages is prejudicial to health in several ways. In the first place, a decaying tooth is always a menace, and especially when the decaying process reaches below the gums. Ulcerations, pyorrhea or Riggs' disease, and other infections of the root of the tooth, are difficult of access and treatment, and for this reason are always to be regarded as a dangerous condition. Aside from the pain and

suffering which these diseases of the teeth produce, we must not forget the possibility of direct infection. So-called blood poisoning and death have been frequent sequelæ of diseased teeth. Some forms of inflammatory rheumatism are thought to be caused by the infection of pyorrhea, and in general the health is injured in proportion as the teeth are affected.

In the second place, defective teeth are a threat to health by reason of impairment of mastication and consequently of digestion. There is no difference of opinion concerning the value of good teeth, properly used, in the preparation of food for the digestive processes. While the vigorous stomach may attack particles of food of considerable size and resistance, the process of digestion is naturally slowed up in proportion to the magnitude and firmness of the unground particles. In addition to this, the admixture of healthy saliva with the food during the process of mastication is of no little consequence, especially in the digestion of starch. Thus defective teeth not only injure by reason of imperfect mastication, but likewise by reason of a failure to properly incorporate the saliva with the finely divided particles of the food while it is still in the mouth.

DENTAL SCHOOL CLINICS

On Monday, the twenty-third of November, 1914, it was my good fortune to be invited to attend the first dental clinic ever held in the city of Washington in a public-school building. Fifty of the progressive dentists of Washington have made an agreement to give two hours of their time per month to a public-school clinic, and the Board of Education has set aside a small room in the Pierce School building, at the corner of G and Thirteenth Streets, Northeast, for the installation of the operating room. Gifts of dental chairs and apparatus have been made by dentists and others, so that the room is now equipped with two chairs and a small but somewhat effective set of apparatus suitable for clinical work on children.

For some time the city of Washington has instituted partial dental inspection of the children in the public schools. From the dental inspector I have obtained the following data: During the two years in which he has been engaged, for part of his time only, in dental inspection, he has examined 10,230 of the school children of the city, between the ages of six and sixteen years. He has found 32,307 cavities in the teeth of these

children. He has found that of the permanent teeth 984 have been lost. He found a total of 81,910 teeth that needed systematic cleaning, and 6,056 that were so far decayed that they needed extracting. Of the total number of children examined, 9,071 had cavities in their teeth and 468 had abscesses at the roots of the teeth. A number of children whose mouths had been examined by the dental inspector were present for the clinic on the date mentioned. One need only look into those neglected mouths and note the ravages of disease and lack of attention and cleanliness to understand the urgent necessity of work of this kind.

It is a matter of shame that the capital city of the country is so far behind many of the other cities in a reform of this nature.¹ It seems almost incredible to believe that until the present time no systematic steps have been taken in Washington to remedy these crying defects. I imagine there are many other cities in the country even as badly off as Washington, and there may be some of the first class that have not yet installed a

¹ In Boston, the Forsythe Dental Infirmary for Children, richly endowed, and housed in an ideal building, has been formally opened.

dental clinic for the benefit of those children whose parents are wholly unable to hire the work which is necessary.

In Washington it is proposed to operate in the public-school clinic only on those children whose parents are unable to meet the expense of the work. Children of parents who are able to pay for the work will be given a card, describing the nature of the work which is necessary to be done, for presentation to their parents, and the school authorities will urge upon the parents the necessity of having this necessary work done. No attempt will be made at the present to bring any pressure to bear upon the parents by excluding their children from school or otherwise. It is evident, however, that the full value of the dental clinic in a case of this kind will not be secured until some method is devised of bringing pressure to bear upon the parents in order that the dental work necessary may be done.

We now have a provision in our public schools which excludes unvaccinated children. This is a wise precaution to prevent the introduction of smallpox into the public schools. When it is remembered, however, that bad mouths, decaying teeth, and neglected gums are doing far greater

damage to the people of the city of Washington than smallpox, we may well ask why we are so careful in regard to the lesser danger and so negligent in the face of the greater? As I looked into the faces of these poorly nourished children, who, even if they had good food, would be unable to properly assimilate it, I was impressed with the magnitude of the work and the great underlying principle of humanity and philanthropy to which it owes its inception and to which it must look for support. It will evidently be some time before the school authorities of Washington are able to secure from Congress the necessary authority and facilities to thoroughly renovate the mouths of the school children of the city.

VALUE OF A WHOLESOME LUNCHEON

In Washington, as in many other places, the value of a good, wholesome luncheon for children has been fully established. By means of a popular subscription, warm luncheons, often with a piece of roast beef, have been provided for many of the indigent children of the city. Improvement in deportment and scholarship was most marked in these cases. Can we doubt that a similar improvement in deportment and scholarship would

attend the renovation of the children's mouths? It seems to me that it would be very proper for this association in some official way to throw its influence toward a general movement throughout the country for betterment of conditions in the mouths of the children. Through the children, best of all, the parents can be reached, and through them the gospel of sanitation and hygiene of the mouth may be carried into the home and made the more effective.

EARLY CONSERVATION OF THE TEETH

Hundreds of the school children in Washington, and I suppose the same is true of other cities, have never been instructed in the use of the toothbrush and know nothing of its value. It seems almost incredible that such crass indifference, threatening the very foundations of society in so far as health is concerned, can prevail. I never realized fully the value of an organization of this kind until I attended this clinic and was overwhelmed with the testimony which was visually presented to me of the necessity of action. As I look at the matter it is highly important that we should begin our work of conservation of the teeth long before the children enter the school.

The tooth is a tissue which needs a particular kind of nourishment. While it is true that there is no such thing as special food for nerves, or brains, or muscles, or teeth, it is true that a properly balanced diet is necessary for the general sustenance of the body. The tissues of the tooth are composed chiefly of lime and phosphoric acid. The foods that contain the proper amount of these bodies are, therefore, fundamental in securing the proper growth of the teeth. The campaign for sound teeth in the child should be inaugurated many years before his birth.

The temporary teeth of children should be good, solid, and enduring, in order that they may remain in place until the permanent teeth are ready to erupt. Otherwise the permanent teeth may be extremely irregular in character and deformed in contour. If decay set in in the temporary teeth, it is highly important that it should be arrested by a filling of a cheap character, but, nevertheless, sufficiently enduring to last as long as the temporary tooth. Thus the proper direction of the permanent teeth is secured, and at the same time they are not subject to any special germ of deterioration by reason of contact with decayed temporary teeth.

FOOD TO PRODUCE GOOD TEETH

In regard to the production of teeth of the right character as a function of food, I may say that the milk of a healthy mother has in it all the elements necessary to nourish the temporary teeth. As some of these teeth, however, erupt after weaning, it is of the utmost importance that the child, after weaning, be fed a diet sufficiently rich in tooth-building material to produce a complete temporary set of teeth of the best quality and to lay the foundations for the production of the permanent teeth. My own experience leads me to believe that the child, after weaning, should receive a generous supply of pure, clean, wholesome milk from tuberculin-tested cows, and at the same time be fed cereals which have not been denatured. Of these, wheat, Indian corn, barley, and oats are types. Rice which has not been polished and which has not lost the important principles of the rice bran may also be given once or twice a week in moderate quantity. As soon as the temporary teeth are sufficiently developed, hard substances, such as toast, zwieback, or graham biscuits, should be given daily in sufficient quantity to develop, by the proper exercise of their functions,

the character of the teeth. Fruits and vegetables suitable for the child's nourishment are not to be neglected. A little spinach once or twice a week is excellent in the furnishing of some of the elements, such as iron, which are important.

The things to be avoided in the nourishment of the teeth of the young child are starch, sugar, candy, and polished rice. The child that is fed good, wholesome milk and such cereals, fruits, and vegetables as I have mentioned, needs scarcely any other adjuvant for the nourishment, not only of his teeth, but of all the tissues of the body. If milk is not given in some considerable quantity, a little powdered carbonate of lime or a little lime-water may be given from time to time to supply the deficiency of lime in the cereals, where the phosphoric element is usually in excess. Such a diet will develop in the child a normal growth of temporary teeth and lay the proper foundations for those of a permanent character. If you do not get good teeth in childhood, you will never have any. The mature molars are of but little account.

NO NATURAL SWEET TOOTH

When the first permanent molars begin to erupt, the necessity for continuing this kind of diet is still paramount. In fact, the whole regimen of the child, as long as growth continues, should be based upon a balanced ration in which all of the elements necessary to nutrition are present in proper quantities. This idea of the balanced ration in respect of the development of good teeth is somewhat at variance with the common practice of dosing children from earliest childhood, in fact, almost during infancy, with sweets. My own experience shows that a child has no natural sweet tooth. If he is not fed sugar and candy and other sweets, he will have no craving for them; in fact, may have a positive dislike for them. Nature not only is one of the best chemists, but also one of the best hygienists. In the sugar which she puts in milk she finds no place for a sweet taste, milk-sugar being almost devoid of sweetness. I am more and more convinced by experience, study, and observation that the common habit of feeding children sugar, candies, and starches is highly detrimental, and especially so to the development of the teeth. It is a common idea, which I think

is a correct one, that the eating of sugar and candy is bad for the teeth. It is not so bad for the teeth, however, in the common acceptance of the term, which implies that the eating of sugar and candy tends to produce decay in the teeth. That, in my opinion, is not the chief objection. The eating of sugar and candy unbalances the ration and interferes with the proper composition of the tooth itself during growth, thus leaving it especially subject to the ravages of decay.

FOOD THE DOMINANT FACTOR

I urge upon this association the careful study of this problem, namely, the proper nutrition of the child to secure a good set of teeth. I believe we will come pretty close to striking at the heart of the trouble when, through investigation and study of this kind, we come to the conclusion that the child's food is the dominant factor in the character of his teeth. In thus emphasizing this important fundamental principle I do not in the least intend to minimize the importance of caring for the teeth once they are formed. The child who has hard, sound, regular teeth needs to be taught the principles of proper care. This means, of

course, in the first place, the proper functioning of the teeth. There must be an abundance of chewing of the right kind, and it must be well done. The tooth is no different from any other organ of the body. To be in prime condition it must be properly exercised. In order that it may be kept from the ravages of decay it must be kept clean. Eternal vigilance is the price of good teeth.

After the age of childhood, the care of the teeth, while not so important, is no less desirable. It is not at all uncommon at the present time to see men and women of middle age with false teeth or none at all. This, of course, means simply improper development of the teeth, in the first place, or carelessness in their use, in the second place. I do not know of any reason why the teeth should not last as long as the eye or the ear or any other organ of the body. While I am aware that age lessens the usefulness of all the organs of the body, I am an advocate of that course of life which would keep all of the organs in synchronic usefulness ending in synchronic decay. My ideal of life is set forth in that wonderful poem of Dr. Holmes (which most people think is only a bit of fun, and yet it is the expression of the most salu-

tary philosophy); namely, the story of the One-Hoss Shay.

Does anyone here doubt that human life would be very much lengthened and made far more endurable if, without the change of any other of the conditions of the environment, we could assure to men and women during their life an excellent, unimpaired, and serviceable set of teeth? It would be extremely unscientific and unwise to make any estimate of how much human life would be lengthened if human teeth were kept in a perfect state, but I would not come far from the truth if I should suggest the average lengthening of life by many years as the reward of such an accomplishment.

HEALTH THE GREATEST BLESSING

I take it for granted that in this association no one will doubt that the greatest of human blessings is health. Health means not only freedom from pain and a capacity for enjoyment, but a great deal more than this. It means ability to serve. We hear much now of efficiency in business. We read of the stories of the efficiency engineer, who goes into a manufacturing establishment and turns a deficit into a profit without

expending a single dollar more than was spent before. It is known as "system" or "efficiency." And so, without increasing in any degree the expense of human existence, we may make it far more effective by the introduction of that system which secures the highest efficiency.

One of the dominant factors in this system is health. We all approve the efforts which are making everywhere to exclude the causes of disease, especially the causes of contagious and infectious diseases. To this end we establish quarantines, we destroy foci of infection, and we arm the individual with an additional resistance by means of vaccination and disinfectants. We teach in our schools and colleges the principles of sanitation. It is a matter of gratification that the principles, as well as the practice, of the sanitation of the mouth are not to be neglected. In one great institution of learning in this country there has been established a department of mouth hygiene under the supervision of Dr. William J. Gies, who has already done special service in studying the chemistry of the mouth. Other great institutions have departments of sanitation, hygiene, and public health. I feel quite certain that the example which has been set by Columbia Uni-

versity will be speedily followed by other institutions of learning throughout the land.

Instructions of this kind will prove more effective than the teachings in the dental schools for professional students. It is a kind of instruction which will filter out through the newspapers and magazines and from the public schools and the pulpits of the country into the homes of all our people. Knowledge is a precedent to effective service in any direction, and effective service in sanitation cannot be accomplished by striking in the dark. We may sometimes by a lucky thrust in the dark strike our antagonist, but we are just as apt to strike a friend. It is the "pestilence that walketh in the darkness" which baffles human endeavor to suppress and not the pestilence which has come out into the open and "wasteth at noon-day." Yellow fever and smallpox and typhoid and measles and whooping-cough and diphtheria are all pestilences which have ceased to walk in the darkness and have come out into the light. These diseases are effectually combated. It is cancer and arterio-sclerosis and Bright's disease and diabetes that are still walking in the darkness. The pestilence that is destroying the teeth of our children or which has not allowed them to

be produced has long been walking in the darkness. We will now bring it to the light, where effective work in guarding against it and in defeating its purposes may be accomplished.

At the Atlantic meeting of the American Medical Association, last June, Dr. Billings read an instructive paper on focal infection as the cause of endocarditis, arthritis deformans, rheumatic fever, nephritis, acute and chronic; myocarditis, exophthalmic goiter, chalicystitis, and diabetes, in which he said:

“The focus of infection may be located anywhere in the body. The usual site is in the head, in the form of alveolar abscess, deep tonsilar or peritonsilar abscess and chronic sinusitis.”

Dr. Thayer, in discussing the paper, said:

“When one meets today a mitral stenosis or insufficiency he proceeds in a very different way from that in which he did twenty years ago. One’s first thought now should be to search for a focus of chronic infection by the removal of which the probability of progression of the malady may be greatly reduced.”

Dr. Anders said:

“If foci of inflammation are found there, they should, of course, be energetically attacked without delay. It is important to recollect that if removal of such focal infections fail to bring about a cure of the condition from which the patient may be suffering, it is not evidence to the contrary, but means, as pointed out by Dr. Billings, that hematogenous metastasis has already taken place.”

Dr. Rochester said:

“I wish to speak of focal infections especially of the teeth and tonsils. In three cases having teeth infections accompanied by endocarditis in which there were no manifest symptoms in the mouth, but in which the Roentgen ray showed an abscess at the roots of the teeth, when the abscess was removed the symptoms subsided and the patients improved clinically. The organism found was the ordinary streptococcus pyogenes.”

While writing this paper, Dr. King, of Washington, told me of a case of diabetes which had just been under his care in which the removal of a pyorrheal tooth effected a speedy disappearance of sugar in the urine.

From the pathological laboratories of the University of Pennsylvania, Drs. Smith, Middleton,

and Barrett have just published a paper on "The Tonsils as a Habitat of Oral Endamebas," in which they say:

"In connection with work recently carried on by Smith and Barrett in the pathologic laboratories of the University of Pennsylvania indicating that the parasitic amebas of the mouth hold an important relation in the etiology of pyorrhea alveolaris or Riggs' disease, and that by the use of emetin (alkaloid) as an amebicide these organisms may be destroyed and the pyorrheal lesions cured, we have sought to determine whether these protozoa may not find their way also into the tonsils and there perhaps be of importance in determining or in maintaining certain of the inflammatory lesions of these structures, at least with or without associated systemic complications. To the present time only the first of these propositions can be said to be proved, that is, that these parasites actually at times involve the tonsils. The conditions of the tonsils of persons in whom they have been found located, and the behavior of several positive cases with systemic complications after the administration of emetin, however, are decidedly suggestive and encouraging to continued investigation now in hand.

"Riggs' disease has for years been suspected of primary relationship to various systemic disturbances, including particularly certain chronic or

recurrent arthritic affections, and possibly, too, some of the anemias of obscure origin and degenerative lesions of various parenchymatous organs; and even greater suspicion, amounting almost to certainty, has attached to tonsillar affections in relation to such systemic complications. Following these ideas, which are essentially those of Hunter and others, the possibility of more generalized influences must necessarily occur, the effects of either the endamebiasis or of the associated bacteria, or both. Direct extension of the inflammatory processes, or lesions due to metastasis by lymphatic or hemic convection, or due to the effects of swallowed or absorbed toxic products, are, logically, at least, to be thought of.

“In several instances in the series of cases treated for pyorrhea by Dr. Barrett there has been noted, after the cure of the pyorrhea, the disappearance of symptoms of gastric and intestinal disorders. Similar experience has been related to us by several dentists following emetin medication; and while perhaps in a few cases this may be due to the happy effect of a coincidence of pyorrhea and amebic dysentery (as in a case communicated by Dr. F. C. Narr, of Philadelphia, to us), this explanation can be accepted only in exceptional instances. It would rather suggest that the cure of the oral lesions has diminished the bacterial and other poisons which previously had

been swallowed and had been causative of some grade of gastritis.

“Whatever other relation may obtain between the amebas and the accompanying vegetable micro-organisms, one may be certain that the amebas feed largely on the latter and in this bacterial phagocytic action they doubtless set free from this and from that organism different endotoxins. Doubtless bacterial toxins thus originating play a more important part than do toxins from the amebas themselves, if there be amebic toxins; and the end-results of toxic absorption are sure, therefore, to vary, now manifesting as hemolysis, now as cellular degenerations or nevroses of fixed tissues, now as inflammatory changes as of synovial or serous membranes.”

Thus it is seen that many of the fundamental conditions which attend common infestations of the mouth reach out in organic connection with some of the most destructive and painful diseases to which we are obnoxious. Mouth hygiene thus establishes an organic relation to diagnosis and therapy in a manner which is most suggestive of proper prophylaxis and remedial treatment.

Pyorrhea alveolaris is the “great white plague” of the teeth, and recent progress in its etiology and treatment is beginning to offer some hope of a

speedy check to this tuberculoid pest. The intra-alveolar injection of a strong solution of bifuoride of ammonia and the intravenous use of emetin are indications of the therapeutic dental triumphs of the near future.

ALL STAND TOGETHER FOR THE PUBLIC HEALTH

All who are here, and many thousands who are not, have enlisted in this army to battle for the public health. There should be no bickerings, nor cross-purposes, nor envy, nor jealousy, to mar the effectiveness of our campaign. There should be no ingress of an attempt to serve mercenary interests under the guise of serving the public health. Allies can be effective only when they work to the same purpose. The National Mouth Hygiene Association has cordial organic relations with the American Public Health Association and with all similar organizations that are battling for the betterment of humanity. It is a good omen that we meet at the same place and in the same rooms and that our audiences are composed of the same people, that we are working in a common cause and our victory will be for the benefit of all humanity.

LESSON XX

MISINTERPRETED DATA

THERE is a widespread belief that the nutrition experts of the Department of Agriculture in the Bureau of Experiment Stations have stated that wheat white flour, that is, the fine patent flour of commerce and other flours similar thereto, has higher nutritive value than the flour made from the whole wheat. This is due to statements made in Bulletin No. 126 of the Department of Agriculture, Office of Experiment Stations, printed in 1903. In order to clear this point up, I quote from the Bulletin, page 50, as follows:

“As shown by analysis, the patent flour, ground from the hard and soft wheats studied, had a somewhat lower protein content than the graham flour and entire-wheat flour ground from the same wheats, but according to the results of digestion experiments with the different grades of flour from these wheats the proportion of digestible protein and the available energy in the patent flour was larger than in the coarser grades. The

lower digestibility of the protein in the latter is, it appears, due to the fact that in these grades a considerable portion of this constituent is contained in the coarser particles (bran), and thus escapes digestion, as it is not acted upon by the digestive juices. Thus, while there may be actually more protein in a given amount of graham or entire-wheat flour than in an equal amount of patent flour ground from the same wheat, the body secures less of the protein and energy from the coarse flour than it does from the fine, since, although the retention of the bran and germ increases the percentage of protein, it decreases the digestibility. By digestibility is meant the difference between the amounts of the several nutrients consumed and the amounts excreted in the feces. No attempt was made to study the ease or rapidity of digestion of the different sorts of flour. When the digestibility of different grades of patent flour was studied it was found that there was no marked difference between standard patent flour and the other grades in this respect. The digestibility of all these flours was found to be high, apparently owing largely to their mechanical condition, that is, owing to the fact that they were finely ground.

“Microscopical studies of the feces from bread made from the different grades of flour indicate that the superior digestibility of patent-flour bread is due to the fineness of division of the flour

particles and also to the fact that the cell walls of the material making up the interior of the wheat berry are less resistant to digestive juices than the walls of the cells making up the outer layers of the grain. In other words, the patent flour is superior as regards digestibility, on account of both its mechanical condition and its physical properties. . . .

“Briefly stated, the most important deductions from the results of these investigations with hard and soft wheat are in accord with the conclusions drawn from the earlier investigations of this series. The nutritive value of flour, in so far as the quantities of digestible protein, fats, and carbohydrates, and available energy are concerned, is not increased by milling the wheat in such a way as to retain a large proportion of bran and germ. The differences in the amounts of total nutrients furnished the body by the various grades of flour are, however, relatively small, all grades being quite thoroughly digested. The coarser flours have a tendency to increase peristaltic action, and are on this account especially valuable for some persons. Judged by composition and digestibility, all the flours are very nutritious foods, which experience has shown are wholesome as well. When also the fact is taken into account that they furnish nutritive material in an economical form, their importance is evident. The fact must not be lost sight of that

using different grades of flour for bread-making and other household purposes offers a convenient method of adding to the variety of the daily diet, a matter which is of undoubted importance.”

A careful study of the above statements shows that no special claim is made that white flour is more valuable than the whole-wheat flour. The general tenor of the text, however, is well suited to induce a belief in the superiority of white flour. It is claimed that the white flour is ground into finer particles and that the nutrient materials contained therein are assimilated to a higher degree than is the case with whole-wheat flour, which is usually coarsely ground. The department bulletin distinctly says that a finely ground wheat flour has less protein than the entire-wheat flour. The same statement is true of its mineral content. Although the proportion of the elements digested is to a very slight degree smaller in the whole-wheat flour, it is evident that there is nothing in the department bulletin to indicate that the total nutritive value is less. There is a larger quantity of excrementitious matter in the feces when whole wheat is eaten, and this in itself is an evidence of its greater wholesomeness. The report of the department recognizes this fact in call-

ing attention to the increased peristaltic action due to the ingestion of whole-wheat products, which is admitted to be valuable to some persons. The common citing of the departmental bulletins as an evidence that finely ground white flour is more nutritious than the whole-ground wheat flour is, therefore, not warranted.

WHOLE-WHEAT FLOUR PREFERRED

There is an almost universal consensus of opinion among dietetic experts to the effect that properly ground whole-wheat flour is a more wholesome product both for children and grown people than the fine wheat flour of commerce. Experiments have been conducted by competent scientists in the feeding of small animals, such as mice, on a diet composed of fine-flour products, on the one hand, and entire-wheat products on the other. Results of these experiments have always been disastrous to the animals fed on the fine-flour products, while normal growth and health have been maintained by those animals fed on the whole-wheat products. It is true that men are not mice; but it would be extremely unwise to conclude that children might eat with impunity an article which, when fed to mice, would produce

emaciation, starvation, disease, and death. The salvation of the human infant is found in the fact that he does not eat these products solely, because if he did there is no reason to believe that the fate of the white-flour-fed mice would not soon overtake him.

There is no question of the excellence of products made from fine-wheat flour. Well-made bread, made of fine white flour, not only has an excellent taste and aroma, but is also highly nutritious when eaten with a mixed diet, especially for workingmen and grown persons. I have no desire to eliminate the white-flour loaf from the table, but I caution parents to guard their children against injury from too much of such a diet. It is delightfully surprising to see how the young child, when fed whole-cereal products, such as properly ground whole-wheat flour, whole-corn flour, whole-oat flour, and whole rice, establishes an appetite and desire for these bodies, which renders their exhibition as foods easy and successful.

IMPORTANCE OF PROPER MILLING

The one important thing is proper grinding, preceded by proper cleaning. The wheat berry,

especially, is difficult to clean. The cleft on one side holds dust with singular persistence. The mere running of the grain through a cleaning mill which removes all detachable matters is not usually sufficient to clean the cleft. It is desirable, when possible, to first have the wheat grains broken by passing through a roller mill, properly adjusted, and afterwards have them cleaned by passing through a wind-blast. In this way almost perfect cleanliness of the grains before grinding is secured. Next, the grinding itself should be done in old-fashioned millstones (buhrs). These should be sharp, perfectly adjusted, and as closely approximated as possible to secure a very finely divided bran. Especially should this be the case when this food is used for infants or invalids. Strong, healthy grown people may eat the coarsely ground wheat flour with apparent impunity. The only loss is in the fact that large flakes of bran are usually excreted without digestion, whereas if the bran is finely ground more or less of its minerals and proteins will be acted upon by digestive ferments.

My advocacy of whole, clean cereal products is based largely upon their mineral content. They contain the salts of lime and of potash, usually

combined with phosphoric acid, which are most useful in digestion and assimilation. It is true the report of the Department of Agriculture, to which attention has been called, contains a somewhat unscientific insinuation that these mineral salts are not assimilated. The report says:

“In view of the fact that there is apparently no satisfactory method for determining the proportion of ash in the feces, derived from metabolic products, and that it is, therefore, impossible by present methods to determine the true digestibility of the mineral constituents, no values for the digestibility of ash have been included in the present bulletin. It may be noted in this connection that it is a well-recognized fact that when the coarser milling products are fed to cattle no great amount of phosphorus (one of the most important manurial elements) is retained in the animal body. This may possibly be an indication that the phosphorus, even if present in considerable amounts in the feed, is not in a form which can be assimilated by animals. This is, however, little more than conjecture, and more experiments with man and the lower animals are needed before satisfactory conclusions can be drawn.”

The last sentence of the above quotation shows that the writer himself did not consider the suppo-

sition of any value. The harm the attitude of the department officials has done is in influencing many readers to believe that these so-called waste products of wheat have no nutritional value. The common experience of dairymen in the feeding of wheat bran shows how erroneous such a conclusion is. It is not expected that the quantity of phosphorus in full-grown animals shall be increased. It is quite different with young animals, such as calves, for they need the phosphorus for growth purposes, and if experiments are made with calves it will be seen how great the content of phosphorus stored in the body is when proper amounts are fed. Fortunately, the experiments on man and the lower animals have been made since the above bulletin was written, and the feeding of animals, especially young animals, on whole-wheat products *versus* fine-flour products has given the information which was wanting. There is no longer any doubt of the fact that the demineralization of our foods, especially the cereal foods, is unscientific, unwise, and unnecessary. A generous mineral diet, as nature has prepared it, is a necessity for the growing child and a desirability for the grown person.

LESSON XXI

CAUSES OF RACE DEGENERATION

IN the last quarter of a century military service has been compulsory in most of the great nations of the world. In England and in the United States during this period military service has been wholly voluntary. Whether compulsory, as in Germany, France, Russia, Italy, and Austria, or whether voluntary, as in England and the United States, the same story comes from all countries. This story is less accentuated in the United States than in any other country, but still its teachings should not be neglected. There are certain bodily qualifications which are considered necessary in a recruit before he can be assigned to military service in the camp or in the field.

Primarily, the recruit must not be suffering from any organic lesion or hereditary taint which renders him physically unfit. In the second place, he must have a certain stature and girth, which are considered necessary to undergo the burdens of the camp, the field, and the battle. At the time

of the Boer War, in England it is stated that two out of every five recruits who offered their services to the king were found physically unfit to endure the hardships of military life. In Germany, several years prior to the beginning of the present war, statistics showed that between 40 and 50 per cent. of the conscripts did not measure up to the standards required for service in the army. These data seem extraordinarily high. It was not possible to alter the stature of the recruits, and, therefore, in order to keep the armies up to the maximum strength required, the physical standards had to be lowered. It is a pretty poor excuse for a man at the present time that will be rejected in Europe by a recruiting officer. Smallness of stature, if it did not carry necessarily diminished strength, would not be a handicap for a soldier, but a positive advantage. The smaller the target, the more difficult to hit. It is evident, however, that in the burdens of army life, especially as war is carried on today, when men live in trenches and under hardships unknown in former wars, lack of physical stamina is likely to cause the recruit to be a burden instead of an aid in military operations.

SEEKING THE CAUSE OF FAILING VITALITY

Many inquiries have been instituted in many countries seeking for the cause of diminishing physical strength and size. Without exception, as these causes have been traced, it is found that under-nutrition or malnutrition of infants and children plays a most important rôle. The question of the proper nourishment of young humanity, therefore, comes squarely up to every country as one of the greatest problems looking to the future advance and prosperity of the nation. The admirable school systems which have been instituted in most countries meet with the just and unqualified praise of every person interested in the welfare of man. May it not be pertinent to inquire, nevertheless, if we are putting the cart before the horse? If Ruskin was right in saying that it is the first business of every man to be a good animal, is not the State wrong in failing to take every precaution necessary to secure a good animal before it undertakes his education?

The first care of the State, it seems to me, should be physical. Where the welfare of the nation is at stake, the right of the State to safeguard its infants and children and bring them up

to a healthy manhood and womanhood must be unchallenged. The first education that the child should have is that which relates to his physical welfare. The mental training comes after without difficulty. If, however, there be no physical basis of health and strength, the effort toward mental training must of necessity fail. The school life which neglects the primary function of education, namely, the health of the child, may prove a curse instead of a blessing.

A GREAT EDUCATIONAL SYSTEM

In the United States we have organized a great national system of education based upon the fundamental idea of instruction in agriculture, the mechanic arts, and military service. This system of education, established at the time of the Civil War, was conceived in the minds of our wise statesmen many years prior thereto. In fact, a bill very much like the one which is now a law was passed by Congress during the presidency of James Buchanan, and was vetoed by the President on the ground that it was unconstitutional. This seems like strange doctrine at the present day, that it is unconstitutional for a country to look after its fundamental welfare.

The Declaration of Independence and the Constitution of the United States specifically regard the pursuit of happiness and the establishment of the public welfare as fundamental rights and duties. That nation which did not look after the beginnings of its citizens and make an effort to safeguard their infancy and childhood would be indulging in neglect which would threaten its very existence. In other words, such a policy is of necessity suicidal. I do not think it a prophecy to say now that in the next years the importance of nutrition and physical training will be realized by all authorities in this country and in the states and cities charged with any duty concerning the welfare of the young. I hardly need to be a prophet to see within a few years a radical change in our system of training in the public schools, and even in the kindergartens of the country, by substituting for much of what is now called mental and technical training a series of fundamental lessons on how to breathe and how to eat and how the body is nourished. It would be a most happy thing if we could go back still further in this matter and instruct the parents of our children along these lines; but that is a difficult, perhaps impossible, undertaking. We must be con-

tent to instruct the children from now on, that the parents of the near future may be competent to supervise the earliest days of life in a scientific, hygienic, and sanitary manner. If we are going to have grown men and women fit for the duties of citizenship, civil and military, we must begin even before birth, and especially at birth, to care for the infants and children.

Just how this is to be done is a matter of detail which is quite insignificant, compared with the necessity of having it done. I have above referred to the system of agricultural, technical, and military instruction which has been, by the generosity of Congress, made possible in every state and territory of our country. Connected with these schools are now very important foundations devoted to the teaching of so-called domestic science. If I understand domestic science, it is the science of the home-life, and the home-life, first of all, is the proper feeding of the inmates of the home. If you think that the mothers and fathers of to-day are capable of safeguarding the welfare of their children, just make a few inquiries and investigations. I do not mean to go among the illiterate contingent of our people, but among the educated and well-to-do and the intelligent. Ask

a dozen mothers at random what are the fundamental necessities of feeding the children after weaning, and see how many of them will have any correct idea of this fundamental problem, lying as it does at the very basis of the happiness of home-life and the welfare and prosperity of the country. Go further than this. Take a dozen physicians at random and ask them for a definition of the proper food of the child—you will be astounded, I am sure, to find how promiscuous an answer will be given. And one need not be surprised at this when he remembers that it is only within a few years that the science of nutrition, so fundamental in medicine, has been taught in medical colleges, and in many of them, at the present time, if the science is taught at all, it is by one not skilled in the very fundamentals of this greatest of all practical sciences.

LACK OF ECONOMY IN CHARITY

Social work is now a fad in many quarters. It is taken up by men and women who are wealthy and who desire honestly to serve humanity. The organized charities of the country, civic and political, have the same object in view. Charity, to be effective, must be economical. The fault with

our charities today is that the overhead charges are often greater than the total direct administration to the wants of the suffering. But that is not the only fault. One great source of weakness in the administration of our charities is in the nutrition of those who are entitled to help. The articles which are collected and administered for food purposes to those who are in a starving or semi-starving condition are far from meeting the wants of the suffering. Coffee, tea, sweetmeats, confectionery, pastry, and other articles of diet which are intended, if for use at all, as luxuries and not as necessities, form a large part of the food which is devoted to the relief of starvation. Our people complain, and justly so, of the high cost of articles of diet. When you compare the price the farmer gets with the price the consumer pays, there is a wide margin of profits to the middlemen. A certain share of profits to the middleman is a necessity of commerce, but it should not be greater than that necessity requires. When the farmer gets 14 cents a gallon for his milk and the consumer pays 40 cents a gallon for the same milk, there must be some fault of an economic character. Granting that a large part of the cost of food is devoted to the transportation and dis-

tribution thereof, the chief cause of the high cost of living is yet unexplained.

I unhesitatingly say that the great waste in the foods of our country is in their unsuitability to the purposes of nutrition. If the workingman and his wife would listen to my plea, and I had the opportunity to go into the home of every wage-earner in the country whose income is less than a dollar and a half a day, I believe I would be able to double the value of his income without giving him a single additional cent, and would be able to make a dollar and a half go twice as far in the nutrition of his family as it does at the present time. I would undertake more than this, to say that the family would be better nourished under a régime which would establish a scientific basis of nutrition than it is at the present time.

These faults of nutrition have of necessity one result, which is of supreme importance, namely, that we are bringing into full citizenship in this country men, and, let us hope, in the near future, women, who are physically unfit, after allowing for all the vices of heredity and all the disadvantages of congregating in large numbers in cities, with the attendant insanitary surroundings. I think we must admit, after all, that the

prime factor in the unfitness of men and women for citizenship when they reach the age of twenty-one is to be traced to faults of nutrition during the early years of their lives.

The efficiency of the individual, the happiness of the family, the welfare of the nation, demand a radical change in our method of instruction. The simple laws which underlie right living are not difficult to explain even to the youngest of our children. I have had no difficulty in imbuing the mind of a boy of three years of age with the fact that he should eat, not according to taste nor desire, but according to what is good for him. This principle might easily be implanted in every child, first at the home, then in the kindergarten, and then in the public school. To this end all social workers, all teachers of physiology and hygiene, all parents interested in the welfare of their children, and all legislators who make laws for the benefit of the country, should unite in one common campaign to improve the system of nutrition practiced throughout our land.

REFORM OF DIET IN ENGLAND

The fundamental importance of wholesome and simple diet to the national welfare is well illus-

trated by the work which is now doing by the educational health and food campaign propaganda in England, under the auspices of the Bread and Food Reform League. This is a purely uncommercial, educational, non-political association. It has received the support of royalty, science, and all classes of society, and directed attention to the subject of food for thirty years. It is not an organization which has been created, therefore, since the beginning of the war, but a third of a century previous thereto. This organization very properly says:

“A knowledge of the right selection and proper preparation of food is of vital interest, and, owing to a calamitous war, the food question is now of momentous importance.”

In its relations to health the council calls attention, in a late publication, which was first published more than thirty years ago, with the approbation of Professors Church, Huxley, Frankland, and Drs. Carpenter, Pavy, and Richardson, to the following statement:

“Wheatmeal bread, made from meal ground to a uniform fineness, which contains all the nour-

ishment of wheat in an easily digestible form, is much more wholesome than white bread; and for children, especially, it is very superior. They cannot grow up strong and healthy unless their food contains sufficient nourishment of the right kind. . . . And there is good reason for thinking that children fed principally on white bread are liable to suffer from rickety bones, consumption, and bad teeth, consequent on an insufficiency of lime and other mineral substances in their food. If these mineral substances are absent from the food, life cannot be sustained.”

All of the investigations which have been made on this subject since confirm the soundness and practicality of the above statement. Much of the success in the effort to secure better food for the people of England has been due to untiring activities of Miss May Yates, who is the executive head of this propaganda of reform in diet.

LESSON XXII

OLD AGE

DIET IN ITS RELATIONS TO OLD AGE

OLD age is a physiological phenomenon which is as unavoidable as birth and as death. There is a natural course of every living being, whether vegetable or animal. There are means, however, at our disposal which, when wisely used, prolong the period of juvenescence and delay senescence, and which, if neglected, exert an inverse influence. The normal life of each individual is peculiar. It depends, first of all, upon his heredity, and, second, upon his environment. As heredity and environment are nearly always different with different individuals, the natural expectation of life for each individual is different. It may be only a variation of a few days, weeks, or months, but at least it is particular in his case.

THE AVERAGE LENGTH OF LIFE

We reach an average statement by combining together large numbers of individual data, and

thus establish what we call an average length of human life. The vital statistics, which are worthy of consideration, in so far as they have been compiled, indicate that in the registration area of the United States, which, in round numbers, embraces two-thirds of the people therein, the average length of human life is approximately forty-four years. This does not seem a very long period, and, in fact, it is not. The average person is just beginning to reach the maximum of his efficiency as a citizen and as a wage-earner at that period of his life. The factor which is most active in reducing the average length of human life is infant mortality. The chances of life of the newborn infant are much less than those of the man twenty, thirty, or forty years of age. In point of fact, as nearly as can be expressed in round numbers, 12 per cent. of all the infants born in the United States die before the age of one year. If this same rate of mortality were continued through the other periods of life, the average period of our existence would be only eight and a half years.

Fortunately, the dangers which threaten life are greatly diminished after the first year, and the resistance to disease is vastly increased after the

fifth year. These two factors act together to make the periods of life after childhood and up to the end of middle life much less subject to death than the first period. As has already been pointed out, the chief cause of the high infant mortality is improper diet, combined as it is with the low resistance of the infant to the inroads of disease. It has been an interesting physiological question to speculate upon the possibility of lengthening human life. There is a universal consensus of opinion among sanitarians, physiologists, and physicians that the span of human life may be very materially extended. In former times it was taught that an animal is likely to live four times as long as it requires to reach maturity. While this law or statement is not based upon strictly scientific observations, it may be accepted as being practically true in so far as the human animal is concerned. If we assume that it requires for the average person twenty years to reach maturity, he ought by that token to live until eighty. That any of us now living shall ever see the arrival of that day when the span of human life is practically twice as great as it is now is very problematical. It is the belief of most students of vital statistics that the average length of

human life at the present time has been increased over that of twenty-five or fifty years ago. There is, however, a difficulty in making the comparison, by reason of the fact that we had no extensive system of vital statistics twenty-five or fifty years ago on which to base our major premise.

ADVANCE OF SANITARY SCIENCE

It is reasonable to suppose that the great advance in sanitary science in the last quarter of a century and the very extensive application of the principles developed by this advance have had a favorable influence on postponing death. It is undoubtedly true that in those sections of the country where the milk supply has been controlled in accordance with the dicta of scientific investigations the death rate of bottle-fed infants has been materially decreased. There are localities in the United States where the death rate of infants under the age of one year has fallen as low as 7, or even 6, per cent. These areas unhappily are not very extensive, and the total effect of the advance of sanitary science and the perfection of our knowledge in the care of infants has not gone far enough to bring the average of the country below the rate noted above. If we make such slow

progress in a case where the road is so clearly marked out, what are we to expect in the way of advance in those cases where there is still much difficulty in finding the road and where the difficulties of progress are enormously greater?

AVERAGE LENGTH OF LIFE

When I was a boy I was told that the average length of human life was about thirty-three years. Probably this is very near the truth at the present time. There are many countries where the average length of human life is very short, as, for instance, in India, where it is considerably under thirty years. There are a few countries where the average length of human life is greater than in the United States. I believe this is true of the Australian countries. In fact, the average length of life in the United States is probably very considerably higher than the average for the whole world, if data could be secured to determine that point. I have intimated that the average length of human life ought to be at least eighty years. Would it be too optimistic to fix that as a goal towards which we should press? I think not. Our aim should be high, even at the risk of undershooting the mark.

DIET THE DOMINANT FACTOR

I hardly need emphasize in this respect how important the diet is in our progress toward the goal. If, as has been illustrated, the chief cause of infant mortality is improper diet, we cannot shut our eyes to the fact that a very considerable fraction of the total mortality of man is due to a similar cause. A reform in our diet, basing its practice upon scientific data of a reliable character, must of necessity increase the average span of human existence. I do not wish to pose as a prophet nor to be over-optimistic, but if a few men and women, by careful control of their diet, by living in a hygienic manner, and by obeying the well-known laws of health, are able to live to seventy, eighty, or even ninety, years of age, it follows that a much larger proportion of men would be able to attain the same end in the same way. This fact alone would be an excuse for writing a book on the influence of food upon health and life, particularly for the ordinary, intelligent reader who does not claim to be a specialist in any line of scientific research.

Seizing upon this idea of the desirability of extending human life and its popularity, various

theories of diet have been founded having for their principal tenet the avoidance of disease and the lengthening of life. The one general fault which attaches to all these theories is the magnification of the effect produced by a cause which apparently, on analysis, is not capable of the accomplishment claimed. It is the old fallacy of logic into which so many people fall, of mistaking the cause of the effect produced—what the logicians call “*non causa pro causa*.” I have not time here to enter into a detailed analysis of these various theories of diet which are advanced with the assurance on the part of their sponsors of perfect success. I exclude from this list of theories all the fakery and deception of the professional exploiters of a gullible public. For my purpose it will be sufficient to develop, in a brief manner, the leading theories or fads which are the basis of the different propagandas.

LESSON XXIII

DIET AND DISEASE

ONE of the results of the more careful study of human diet which has characterized the attitude of investigators and physiologists during the last third of a century has been the recognition of the importance of food, both as a causative and curative agent in disease. As a student of medicine at the time when the medical profession was undergoing its great transformation, namely, from 1870 to 1880, I was frequently struck with the fact, as I studied the causes of disease in hospitals, of the great prevalence of diseases of the digestive organs. A careful study of the inception of these diseases led me to the conclusion that they were caused largely by faults of diet.

Food causes disease in a number of ways. First, the lack of food, fasting, or starvation reduces very rapidly the vitality of the body and renders it less able to resist the inroads of infec-

tious and contagious diseases. Lack of nourishment thus threatens, not only life, but, in case of relief and a supply of food before starvation reaches a fatal end, it predisposes to diseases of many other kinds. Second, a very great variety of diseases is produced by excess of food. Whenever more food is ingested than is necessary for the ordinary course of life and for the slight reserve which is always advisable to be kept on hand, it is disposed of either by being stored as fat or glycogen or by being converted into heat and energy. Superabundance of food thus keeps the body in a state of plethora. There is too much blood; the blood pressure is apt to become greater. The secreting organs of the body are overworked and fail to do their proper part, and all of the organs suffer from the burdens which are placed upon them by the excess of food.

There are certain diseases which have been peculiarly associated with superabundance of food. Among these gout perhaps takes the leading rôle. Generous living and gout are associated by common consent, but gout is not by any means the only disease which overeating may produce. The excess of work upon the excretory organs has the effect of exhausting them, so that they fail to per-

form their work as well as they should. The products which should be excreted are, therefore, left largely in the blood or tissues of the body. These products are often of a poisonous nature. The result is a breaking-down of the resisting power of the body and an opening of the way for various forms of disease. This is manifested usually in failure of the digestive organs under the great burdens placed upon them.

These disorders of the stomach often begin simply by what is called heartburn or hyper-acidity. When the stomach is filled with a great volume of food the acids which are natural to the stomach are greatly diluted. At the same time, the food in the stomach excites a much larger flow of digestive acids, and after a while they are found to be present in excess. Those who have suffered from so-called heartburn are aware of the fact that it comes on from an hour to two or three hours after eating. You are also aware of the fact that additional quantities of food relieve the unpleasant sensation, due, of course, to a dilution of the acid. Hyper-acidity is one of the forerunners of dyspepsia (indigestion). After a while the overworked organ becomes almost useless, and serious effects result, ending in an inability of

the digestive organs to furnish enough food to support the ordinary functions of the body.

As a sequel of indigestion, all kinds of infectious and contagious diseases may be set up. Various forms of skin disease are traced often to a faulty stomach. Worst of all, the vitality of the body is so diminished and the power of assimilation so disordered that the circulatory system itself becomes seriously affected. The coats of the arteries become hard and unyielding. The volume of the blood is so great as to burden the heart. The blood pressure increases, producing a pressure on the heart walls which causes them to dilate. The heart becomes large and its walls weak. The condition of arterial sclerosis, which is such a common enemy of middle and after-middle life, is set up. Following or synchronous with these troubles are various forms of diseases of the kidney, which also becomes an overworked organ and seeks retaliation by setting up a diseased condition which is a threat to life. The two most important diseases of the kidneys are, first, that condition of malnutrition which leaves the sugar unburned in the body and causes it to appear in the urine. This disease may not be essentially a kidney disease. It is probably asso-

ciated with disorders of the functions of the liver particularly. At any rate, the kidney is called upon for a new burden, namely, to separate sugar from the circulatory liquids and excrete it, instead of having it properly burned up into carbon dioxide and water in the tissues of the body. Diabetes is a very common result of overeating and overdrinking.

Another kidney disease which is directly connected with excessive food ingestion is albuminuria (Bright's disease). The presence of albumen in the circulatory fluids and in the tissues in such quantities as to be removed in the urine is an expression of a very grave disorder of the body which, if not speedily checked, will lead to fatal results. There is no doubt in my mind that Bright's disease, as a rule, may be traced directly to the evils of overeating. Other degenerative diseases of old age, such as cancer, are of obscure origin, and have not been directly connected with faults of diet. I am led to the conclusion, nevertheless, that many of the unknown causes of degenerative diseases of this kind may be connected very intimately with faults of diet, and usually with overeating. Thus it is seen that, from the point of view of the causation of disease,

all kinds of disorders may arise, both from an insufficient quantity of food and also from an excessive quantity of food.

The degenerative diseases incident to old age serve to counteract the effect of diminished infant mortality.

DISEASE DIRECTLY CAUSED BY FOOD

Food also is a direct cause of disease. If reasonably wholesome foods are eaten in any large quantities with imperfect mastication, so that the stomach is entirely overloaded and unable to rid itself of the load, we have that very common difficulty of sour stomach, nausea, vomiting, and diarrhea. Even if food be wholesome, excessive quantities of it may produce these results. On the other hand, if a food itself be unwholesome, be partly on the road to decomposition, or contain some specific poisonous ingredient, it produces a genuine intoxication, beginning in the stomach and extending through the intestines to all parts of the body. This condition of affairs is very often called ptomaine poisoning. Ptomaines are supposed to be the results of the decomposition of animal nitrogenous tissues in the body. The word itself means "a dead body." Ptomaine poisoning

is a general expression applied to a toxic condition caused by food rather than a definite pointing out of the nature of the disturbing body.

Certain ptomaines have been discovered and isolated from food products, but only with great difficulty and often without being able to repeat successfully the quest. Hence we cannot set down any specific ptomaines of definite composition as the cause of the difficulties which I have described. In general, sickness from these causes is described as food poisoning, and, alas! too often fatal results follow. Fresh foods never produce ptomaine poisoning. Preserved foods of all kinds may possibly do so unexpectedly. Vegetable foods are less likely to develop ptomaines than animal foods, such as milk, fish, meat, cheese, et cetera.

It follows that food is a pregnant cause of disease. It either diminishes the vitality of the body when present in too small quantity, or it overburdens the organs of the body when present in too large quantities, all of these conditions inviting the entrance of contagious and epidemic diseases. Excessive food tends to produce disturbance of the digestive organs—dyspepsia, heartburn—and in this way diminishes the ability of the digestive tract to properly nourish the body,

favoring the same condition of sensibility to disease which has just been described. Bad foods may act specifically by the presence of poisonous bodies which produce extreme nausea, vomiting, and even death, without the investigator being able, as a rule, to distinguish any distinct definite chemical compound which would correspond to the chemical idea of ptomaines.

As an illustration of the powerful effect of food in causing disease, I may call attention to the summer complaint of children. By the term "summer complaint" I mean to embrace all the various forms of intestinal disturbance and diarrhea from which children so commonly suffer in hot weather. It is not difficult to show that in all these cases bad food has been the moving cause. The infection has been introduced and promoted by its presence. Inasmuch as a very large percentage of all infants who die under the age of one year die of intestinal trouble, the importance of pure food for the infant as a means of preventing disease, and especially fatal disease, is at once shown.

There are certain common articles of food which produce serious disturbances of health in certain people who have an acute sensibility to their in-

fluences. It is well known that egg is poisonous to some people. The ingestion of small quantities of it produces very serious effects. Strawberries cannot be eaten by some people for the same reason. In fact, almost all people have some particular pet abhorrence in the way of a food product, and the attempt to eat a product of this kind usually results disastrously. It is the part of wisdom in all persons, in relation to their foods, to study carefully the quantities necessary for their maintenance in ordinary condition and to use only simple, wholesome, and clean foods, and in moderate quantities. Children may be controlled, if the parents really desire it, so that they do not have access to those foods which bring on diarrhea.

Bad milk is the most frequent cause of this trouble. How often the parent allows the child to choose its own food, often unwisely, rather than insist on following the plain dictates of enlightened hygiene! Food is not only our sustenance, but also in many cases the cause of our taking-off.

SPECIFIC FOOD DISEASES

There are certain specific diseases caused by certain faults in nutrition which are now well es-

tablished. It has long been known that scurvy, which manifests itself by a peculiar affection of the gums, but is, in fact, a systemic disease, is caused by eating cured or canned foods exclusively. Persons suffering with scurvy soon recover if they can have fresh vegetables, fresh milk, and fresh meats. Closely allied with scurvy is the disease known as beri-beri, which is produced by eating a diet too rich in carbohydrates and poor in mineral and nitrogenous foods. Beri-beri was a very common disease in rice-eating countries where the practice of polishing the rice before consumption gained a vogue. Men who live almost exclusively on a diet of polished rice are very apt to acquire the disease known as beri-beri. An interesting thing in connection with this disease is that if the bran of the rice which is removed in polishing be used as a medicine, the disease is diminished, and even cured. The eating of white flour as an exclusive diet causes a similar disease. These facts accentuate the importance of eating whole cereals in all cases where the food is largely composed of cereals.

Pellagra is a disease the cause of which is still to some extent unknown. Recent investigations of the Health Service of the United States seem to

indicate that pellagra is also a diet disease. In those localities where pellagra flourishes it is found that the poor people, especially, eat a diet in which the carbohydrates are in great excess and the mineral and nitrogenous foods correspondingly deficient. Pellagra, which is a disease very resistant to ordinary treatment, yields very readily when the patients are placed upon a generous diet in which the minerals and the protein are restored to their proper proportions.

There are certain diseases of the teeth which also are intimately associated with an improper diet. Whenever the mineral substances and nitrogenous substances in the foods of children are reduced below the normal there is a threat to the proper nutrition of the teeth. Without sufficient material for growth the teeth cannot be expected to attain the degree of strength and solidity proper for the discharge of their functions and to secure immunity against disease. The eating of excessive quantities of candy and sugar is known to be hurtful, in so far as the teeth are concerned. These foods have no materials out of which teeth can be built, and they also seem to exert a specific harmful influence by promoting fermentation between the teeth and the

development of an acid which softens the enamel. Children who eat large quantities of candy continually are generally found to have bad teeth.

Rickets is another disease, especially of the bony structure, which is intimately connected with diet. Children who have rickets always suffer from some form of malnutrition. The form most common is a deficiency in the nutritive matters from which the bones are formed. The bones of the child, therefore, remain soft and yielding, and the bony structure is unable to support the weight of the body. Deformities, especially of the legs, result constantly in rickety children. Also, the skull is apt to fail to harden, and thus promotes the excretion of fluids in the membranes of the brain, which enlarge the head, destroy the intellectual capacity, and bring the child-life to a most unfortunate end.

CURATIVE PROPERTIES OF FOODS

Inasmuch as foods are known to have such an important function in the causation of disease, it is not strange that the attention of the medical profession has been called to the possible value of foods remedially. It seems a common-sense proposition to suppose that if a given disorder

has been brought on by improper food it may be speeded on its exit by returning to a proper diet. The case is not so easy, however, as it looks. Improper food not only specifically hurts, but also incidentally, as has been shown. When the disease incident to bad food once takes a hold it may be beyond the reach of proper food to eradicate it.

Unfortunately, the general principle that food may be used to promote recovery from disease has led to the development of many false ideas concerning its efficacy. This development has even gone so far as to bring food down to the plane of the patent nostrum. Newspapers and magazines have been carrying advertisements far and wide offering to cure all forms of disease by prescribing a particular form of diet. The reader cannot be too skeptical concerning all such claims. Even the educated and trained physician who has the patient in charge knows what a hard task he has to restore the health of a person suffering from dyspepsia. It is often necessary to feel one's way in the direction of foods which the dyspeptic may tolerate, and thus preserve to a certain extent his vigor. That a person *in absentia* can prescribe a diet for a case of this kind is absurd upon its face. Yet thousands of our people

have been defrauded by trusting the promises of these quacks and fakers. It has been necessary in some cases to evoke the laws against fraud by prohibiting the use of the mails for advertising remedial foods. You may at once conclude that the person who offers to cure you, without a personal inspection, of any disease from which you suffer by prescribing a certain kind of a diet, will accomplish no result of any value except the increasing of his bank account and the diminution of yours to a like amount. On the other hand, the careful selection of food by a competent expert and the persistence in a course of rational diet on the part of the patient may secure most valuable and successful results if the patient will follow it out.

There is one disease particularly in which a proper diet is of the greatest importance. Tuberculosis is the scourge of humanity. This disease of the lung or other parts of the body caused by a particular organism is usually beyond the direct reach of remedial applications. The administration of drugs hypodermically or through the stomach cannot possibly reach the seat of the trouble. They often do worse than fail—they diminish still more the vitality of the body to re-

sist disease. Large experience has shown that the only successful treatment of tuberculosis is to keep the patient in the open air, without allowing him to exert himself violently either physically or mentally, keeping him away as far as possible from business, placing him in agreeable surroundings, and feeding him a generous diet in which milk and eggs occupy a very important position. The outdoor life of freedom from care, and the rest, combined with a good nutrition, often succeeds in arresting, or even eradicating, the disease. Other forms of disease, where the vitality of the body has sunk very low, may be combated, at least for a time, by a careful study of the possibilities of nourishing the body directly through nutritious and adaptable foods.

The fakery and deception which have characterized many of the propagandas relating to the influence of food on health, and especially its curative powers, have had a depressing effect upon the general public, and even upon professional men, in their estimation of the true functions which the food performs. Nevertheless, a patient investigation has succeeded in elucidating some of the fundamental principles which underlie this problem. Some notable books have been recently

published devoted to this theme. Among these the fourth edition of "Diet in Health and Disease," by Friedenwald and Ruräh, holds the first place. A more popular exposition of the subject is found in the book of Lorand, entitled "Health Through Rational Diet." Dr. Bishop also has published a most interesting contribution to this study in his book, "The Causes and Treatment of Arterio-Sclerosis." Dr. Bishop confines himself to the function of food in retarding or removing the conditions which are grouped together under the rather unfortunate name of arterio-sclerosis, which, being translated, means "hardening of the arteries." The disease, however, is of a much wider significance than this name implies. It is peculiarly systemic, and affects not only the arteries, but especially the heart, and incidentally the excretory organs. This very considerable volume of literature illustrates the interest which scientific men are now taking in this matter.

TAKING THE WATERS

In addition to this, we should not forget the large numbers of sanatoria which have been established throughout the country, in which the principal benefit secured by those suffering from

disease undoubtedly results from a wise ordering of the diet. It has long been recognized that persons in easy circumstances—in other words, well-to-do or rich—derive considerable benefit from “taking the waters,” meaning by that a sojourn of from one to two months per year at some of the so-called health springs. In this country there are various resorts of this kind, the more important of which are the Hot Springs of Virginia, the Hot Springs of Arkansas, the springs at West Baden, Indiana, and the springs under the control of the State of New York at Saratoga. Among these springs those at Hot Springs, Arkansas, and at Saratoga are under the control of the United States and the State of New York, respectively. Large numbers of invalids, especially those suffering from rheumatism and similar chronic diseases, resort to these springs each year, and receive, as a rule, benefit from their sojourn. While the waters undoubtedly have something to do with this, the most important curative functions, in my opinion, are exercised by the freedom from care, the rest, and the restriction of the diet. Muldoon has a resort in New York of a similar character, which is particularly frequented by those who have broken down in public life. The water of these

resorts is not regarded as of any very great significance. They probably are not at any other places. They become, however, a rallying point or means by which the invalids are attracted and put into an environment where the diet and the freedom from care and worry are permitted to improve health and strength.

LESSON XXIV

PRACTICAL (APPLIED) PRINCIPLES OF NUTRITION

IT is interesting and instructive to have access to the data which give reliable information respecting the composition of foods and to understand the functions which each class of food constituents exercises. This knowledge does not reach its full value until it is applied in the market, the kitchen, and the dining-room. The object of the present chapter is to enable the attentive reader of this book to get practical benefit from it in his daily life. The fundamental data which have been presented are now to be arranged in a form for home use.

The United States Department of Agriculture has made extensive studies in the Bureau of Chemistry and the Office of Experiment Stations of foods, dietaries, and nutrition. The investigations of dietaries and nutrition were under the direction and inspiration of the late Dr. W. O. Atwater, who was the pioneer among the nutri-

tion investigators of this country. The results of all these studies, including the investigations of food adulterations and their effect on health, are published in numerous bulletins of the Bureau of Chemistry and the Office of Experiment Stations during the past thirty years.

In order that these data may be utilized in the arrangement of scientific bills-of-fare, they have been tabulated and adapted to common use. The base analyses are copied from the tables in Bulletin No. 28 (revised edition) of the Office of Experiment Stations, by Atwater and Bryant. The data representing the Calories per kilogram, grams per 100 Calories, and ounces per 100 Calories were calculated by the author. From these calculated data the quantities of all common foods to make a balanced ration of any chosen number of Calories can be easily ascertained. In computing the quantities the data representing the edible portion of the food are used. The data representing the value of the foods "as purchased" are very important from the economical point of view, inasmuch as they indicate the losses suffered in the refuse portions, and are, therefore, included in the tables.

TO CONSTRUCT A RATION OF ANY GIVEN NUMBER
OF CALORIES

For a basic ration it is convenient to select one representing 1,000 Calories, one meal for the average active man, so adjusted that one-sixth of the heat units is derived from protein and five-sixths from carbohydrates and fats.

The typical meal does not include soups, coffee, tea, or dessert, since these items are mostly stimulants, or, in the case of sweets, unbalanced food adjuvants which, on the whole, were better omitted. Let us choose a meal consisting of bread, butter, milk, meat, and potatoes. By consulting the tables the following data (whole numbers) are obtained:

TYPICAL MEAL

	Ounces	Calories
Bread	3	200
Roast beef	3	250
Milk	16	300
Butter	0.5	100
Potatoes	6	150
Total	28.5	1000

In all cases the quantities refer to the edible portion.

From the percentage of protein in these food products and the quantities used in the ration it is

found that the 1.5 ounces of protein in the meal furnished 160 (round) Calories and the carbohydrates and fats 840 Calories. This ration, therefore, has a nutritive ratio of 5 (round). Assuming that the mineral content of the ration which is not included in these calculations is of the right kind and amount, three meals of the above proportions furnish an ideal ration of the average man at active work for one day.

INDEX FOR CONVENIENCE IN USING TABLES

Among a multitude of data arranged by groups of like kinds the particular article of diet will be hard to find. The food products, which include most of the kinds commonly consumed, are arranged alphabetically in the following table index.

TABLE I.—MEATS.

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. +Carbohydrate.	Calories per Kilo.	Calories per Pound,	Grams per 100 Calories.	Ounces per 100 Calories.
Beef Ribs, lean. {	*E. P.	....	67.9	19.6	12.0	....	1,914	870	52.2	1.84
	*A. P.	22.6	52.6	15.2	9.3	....	1,485	675	67.3	2.41
Ribs, fat..... {	E. P.	....	48.5	15.0	35.6	....	3,916	1,780	25.5	0.91
	A. P.	16.8	39.6	12.7	30.6	....	3,355	1,525	29.8	1.07
Ribs, all analy- ses..... {	E. P.	....	57.0	17.8	24.6	....	3,014	1,370	33.2	1.18
	A. P.	20.1	45.3	14.4	20.0	....	2,442	1,110	41.0	1.46
Beef, Tender- loin..... {	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	59.2	16.2	24.4	....	2,926	1,330	34.2	1.22
Bacon, lean.... {	E. P.	....	31.8	15.5	42.6	....	4,587	2,085	21.8	0.78
	A. P.	17.0	26.5	18.0	35.5	....	3,828	1,740	26.1	0.93
Bacon, medium fat..... {	E. P.	....	18.8	9.9	67.4	....	6,660	3,030	15.0	0.53
	A. P.	7.7	17.4	9.1	62.2	....	6,149	2,795	16.3	0.58
Bacon, all analyses..... {	E. P.	....	20.2	10.5	64.8	....	6,446	2,930	15.5	0.55
	A. P.	8.7	18.4	9.5	59.4	....	5,907	2,685	16.9	0.6
Beef, corned, all analyses... {	E. P.	....	53.6	15.6	26.2	....	3,069	1,395	32.5	1.16
	A. P.	8.4	49.2	14.3	23.8	....	2,796	1,271	35.8	1.27
Beef Kidneys.. {	E. P.	....	76.7	16.6	4.8	0.4	1,144	520	87.4	3.12
	A. P.	19.9	63.1	13.7	1.9	....	737	335	135.7	4.8

* E. P. = Edible Portion. A. P. = As Purchased.

† Meat of freshly killed animals and of the horse and lobster have small quantities of a carbohydrate-yielding body, glycogen.

TABLE I.—MEATS.—(Continued.)

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories
Lamb, leg, hind, all analyses..	E. P.	....	58.6	18.6	22.6	....	2,860	1,300	84.9	1.25
	A. P.	13.8	50.3	16.0	19.7	....	2,486	1,130	40.2	1.43
Mutton, hind leg, lean.....	E. P.	....	67.4	19.8	12.4	....	1,958	890	51.1	1.9
	A. P.	16.8	56.1	16.5	10.3	....	1,628	740	61.4	2.19
Mutton, hind leg, fat.....	E. P.	....	55.0	17.3	27.1	....	3,223	1,465	31.0	1.11
	A. P.	12.4	48.2	15.2	23.8	....	2,838	1,290	35.2	1.26
Mutton, hind leg, all analy- ses.....	E. P.	....	63.2	18.7	17.5	....	2,387	1,085	41.9	1.5
	A. P.	17.7	51.9	15.4	14.5	....	1,980	900	50.5	1.8
Ox tail, canned.	E. P.	....	67.9	26.3	6.3	....	1,661	755	60.2	2.20
	A. P.	29.7	47.7	18.5	4.5	....	1,177	535	85.0	3.03
Pork, Tender- loin.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	66.5	18.9	13.0	....	1,980	900	50.5	1.8
Sausage, average Pork.	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	39.8	13.0	44.2	1.1	4,675	2,125	21.4	0.76
Sweetbreads, Beef.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	70.9	16.8	12.1	....	1,815	825	55.1	1.97
Chickens, Broilers.....	E. P.	....	74.8	21.5	2.5	....	1,111	505	90.0	3.2
	A. P.	41.6	43.7	12.8	1.4	....	649	295	154.1	5.5
Tongue, Beef (Ox).....	E. P.	....	70.8	18.9	9.2	....	1,628	740	61.4	2.2
	A. P.	26.5	51.8	14.1	6.7	....	1,199	545	83.5	2.98

TABLE I.—MEATS.—(Continued.)

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Kidneys, Mutton.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	78.7	16.5	3.2	....	968	440	103.3	3.7
Fowls.....	E. P.	....	63.7	19.3	16.3	....	2,299	1,045	48.5	1.55
	A. P.	25.9	47.1	13.7	12.3	....	1,705	775	58.7	2.08
Turkey.....	E. P.	....	55.5	21.1	22.9	....	2,992	1,360	33.4	1.2
	A. P.	22.7	42.4	16.1	18.4	....	2,365	1,075	42.3	1.5
Eggs, Hens'....	E. P.	....	73.7	13.4	10.5	....	1,584	720	63.1	2.3
	A. P.	11.2	65.5	11.9	9.3	....	1,897	635	71.6	2.55
Crab meat	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	77.1	16.6	2.0	1.2	913	415	109.5	3.91
Crabs, hard- shell, whole..	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	52.4	36.7	7.9	0.9	0.6	429	195	233.1	8.3
Oysters in shell	E. P.	....	86.9	6.2	1.2	3.7	517	235	193.4	6.9
	A. P.	81.4	16.1	1.2	0.2	0.7	99	45	1010.1	36.1
Oysters, bulk..	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	88.3	6.0	1.3	3.3	506	230	197.6	7.06
Lobsters, whole	E. P.	....	79.2	16.4	1.6	0.4	858	390	116.5	4.1
	A. P.	61.7	30.7	5.9	0.7	0.2	308	140	324.7	11.59
Scallops.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	80.3	14.8	0.1	3.4	759	345	131.8	4.71

TABLE II.—VEGETABLES, FRESH.

NAME.	Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Artichokes..... { E. P.	....	....	....	....	....	....	....	....	....
{ A. P.	....	79.5	2.6	0.2	16.7	803	365	124.5	4.45
Asparagus..... { E. P.	....	....	....	....	....	....	....	....	....
{ A. P.	....	94.0	1.8	0.2	3.3	231	105	432.9	15.4
Beets..... { E. P.	....	87.5	1.6	0.1	9.7	473	215	211.4	7.5
{ A. P.	20.0	70.0	1.3	0.1	7.7	374	170	267.4	9.55
Beets, cooked.. { E. P.	....	88.6	2.3	0.1	7.4	407	185	245.7	8.8
{ A. P.	....	....	....	....	....	....	....	....	...
Beans, String.. { E. P.	....	89.2	2.3	0.3	7.4	429	195	233.1	8.3
{ A. P.	7.0	83.0	2.1	0.3	6.9	396	180	252.5	9.02
Cabbage..... { E. P.	....	91.5	1.6	0.3	5.6	319	145	313.4	11.2
{ A. P.	15.0	77.7	1.4	0.2	4.8	275	125	363.6	12.98
Carrots..... { E. P.	....	88.2	1.1	0.4	9.3	462	210	216.4	7.7
{ A. P.	20.0	70.6	0.9	0.2	7.4	352	160	284.1	10.14
Caniflower { E. P.	....	....	....	....	....	....	....	....	....
{ A. P.	....	92.3	1.8	0.5	4.7	308	140	324.7	11.59
Celery..... { E. P.	....	94.5	1.1	0.1	3.3	187	85	534.7	19.1
{ A. P.	20.0	75.6	0.9	0.1	2.6	154	70	649.3	23.19
Corn, green.... { E. P.	....	75.4	3.1	1.1	19.7	1,034	470	96.7	3.4
{ A. P.	61.0	29.4	1.2	0.4	7.7	396	180	252.5	9.02

TABLE II.—VEGETABLES, FRESH.—(Continued.)

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Cucumbers	E. P.	....	95.4	0.8	0.2	3.1	176	80	568.2	20.3
	A. P.	15.0	81.1	0.7	0.2	2.6	154	70	649.3	23.19
Eggplant	E. P.	....	92.9	1.2	0.3	5.1	286	130	349.7	12.48
	A. P.	....	....	....	....	....	....	....	....	....
Leeks.....	E. P.	....	91.8	1.2	0.5	5.8	330	150	303.0	10.82
	A. P.	15.0	78.0	1.0	0.4	5.0	286	130	349.7	12.48
Lettuce	E. P.	....	94.7	1.2	0.3	2.9	198	90	505.1	18.03
	A. P.	15.0	80.5	1.0	0.2	2.5	165	75	606.1	21.64
Onions.....	E. P.	....	87.6	1.6	0.3	9.9	495	225	202.0	7.21
	A. P.	10.0	78.9	1.4	0.3	8.9	451	205	221.7	7.92
Parsnips	E. P.	....	83.0	1.6	0.5	13.5	660	300	151.5	5.41
	A. P.	20.0	66.4	1.3	0.4	10.8	528	240	189.4	6.76
Peas, Green....	E. P.	....	74.6	7.0	0.5	16.9	1,023	465	97.7	3.49
	A. P.	45.0	40.8	3.6	0.2	9.8	561	255	178.2	6.8
Potatoes.....	E. P.	....	78.3	2.2	0.1	18.4	847	385	118.1	4.22
	A. P.	20.0	62.6	1.8	0.1	14.7	682	310	146.6	5.2
Potatoes, Sweet	E. P.	....	69.0	1.8	0.7	27.4	1,254	570	79.7	2.85
	A. P.	20.0	55.2	1.4	0.6	21.9	1,012	460	98.8	3.53
Pumpkin.....	E. P.	....	98.1	1.0	0.1	5.2	264	120	378.8	13.53
	A. P.	50.0	46.5	0.5	0.1	2.6	132	60	757.6	27.05

TABLE II.—VEGETABLES, FRESH.—(Continued.)

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Radishes.....	E. P.	....	91.8	1.3	0.1	5.8	297	135	336.7	12.02
	A. P.	30.0	64.3	0.9	0.1	4.0	209	95	478.5	17.08
Rhubarb.....	E. P.	....	94.4	0.6	0.7	3.6	231	105	432.9	15.5
	A. P.	40.0	56.6	0.4	0.4	2.2	143	65	699.3	24.98
Spinach.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	92.3	2.1	0.3	3.2	242	110	413.2	14.7
Squash.....	E. P.	....	88.3	1.4	0.5	9.0	473	215	211.4	7.55
	A. P.	50.0	44.2	0.7	0.2	4.5	231	105	432.9	15.4
Tomatoes.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	94.3	0.9	0.4	3.9	231	105	432.9	15.4
Turnips.....	E. P.	....	89.6	1.3	0.2	8.1	407	185	245.7	8.8
	A. P.	30.0	62.7	0.9	0.1	5.7	275	125	363.6	12.98

TABLE III.—VEGETABLES, CANNED.

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Asparagus	E. P.	*	....	....	....	....	....	....	....	....
	A. P.	....	94.4	1.5	0.1	2.8	187	85	534.8	19.1
Beans, baked...	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	68.9	6.9	2.5	19.6	1,320	600	75.8	2.71
Beans, Lima....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	79.5	4.0	0.3	14.6	792	360	126.3	4.5
Beans, String..	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	93.7	1.1	0.1	3.8	209	95	478.4	17.1
Beans, Wax....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	94.6	1.0	0.1	3.1	176	80	568.2	20.3
Beans, Haricots, Verts, average.	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	95.2	1.1	0.1	2.5	154	70	649.3	23.2
Beans, Hari- cots, Flageo- lets, average.	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	81.6	4.6	0.1	12.5	704	320	142.0	5.07
Corn.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	76.1	2.8	1.2	19.0	1,000	455	100.0	3.6
Horseradish....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	86.4	1.4	0.2	10.5	506	230	197.6	7.06
Horseradish, evaporated...	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	4.3	11.0	0.8	77.7	3,707	1,685	27.0	0.96

* In articles which are all edible A. P. and E. P. are synonymous terms.

TABLE III.—VEGETABLES, CANNED.—(Continued.)

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Macédoine, mixed vege- tables.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	93.1	1.4	....	4.5	242	110	418.2	14.8
Peas, Green....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	85.8	3.6	0.2	9.8	561	255	178.2	6.3
Okra.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	94.4	0.7	0.1	3.6	187	85	534.8	19.1
Pumpkin.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	91.6	0.8	0.2	6.7	330	150	308.0	10.8
Tomatoes.....	E. P.	....	....	....	....	....	....	....	....	....
	A. P.	....	94.0	1.2	0.2	4.0	231	105	432.9	15.4

TABLE IV.—FRUITS, FRESH.

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Apples.....	{ E. P.	....	84.6	0.4	0.5	14.2	638	290	156.7	5.6
	{ A. P.	25.0	63.3	0.3	0.3	10.8	484	220	206.6	7.4
Apricots.....	{ E. P.	....	85.0	1.1	....	13.4	594	270	168.3	6.01
	{ A. P.	6.0	79.9	1.0	....	12.6	561	255	178.2	6.4
Bananas.....	{ E. P.	....	75.3	1.3	0.6	22.0	1,012	460	98.8	3.53
	{ A. P.	35.0	48.9	0.8	0.4	14.3	660	300	151.5	5.41
Blackberries ...	{ E. P.	....	....	....	....	....	....	....	....	....
	{ A. P.	....	86.3	1.3	1.0	10.9	594	270	168.3	6.01
Raspberries, red.....	{ E. P.	....	....	....	....	....	....	....	....	....
	{ A. P.	....	85.8	1.0	....	12.6	561	255	178.2	6.4
Raspberries, black	{ E. P.	....	....	....	....	....	....	....	....	....
	{ A. P.	....	84.1	1.7	1.0	12.6	682	310	146.6	5.2
Cherries.....	{ E. P.	....	80.9	1.0	0.8	16.7	803	365	124.5	4.45
	{ A. P.	5.0	76.8	0.9	0.8	15.9	759	345	131.7	4.7
Cranberries.....	{ E. P.	....	....	....	....	....	....	....	....	....
	{ A. P.	....	88.9	0.4	0.6	9.9	473	215	211.4	7.5
Grapes.....	{ E. P.	....	77.4	1.3	1.6	19.2	990	450	101.0	3.61
	{ A. P.	25.0	58.0	1.0	1.2	14.4	737	335	135.7	4.8
Lemons.....	{ E. P.	....	89.3	1.0	0.7	8.5	451	205	221.7	7.92
	{ A. P.	30.0	62.5	0.7	0.5	5.9	319	145	313.5	11.2

TABLE IV.—FRUITS, FRESH.—(Continued.)

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Watermelons ..	{ E. P.	....	92.4	0.4	0.2	6.7	308	140	324.6	11.6
	{ A. P.	59.4	37.5	0.2	0.1	2.7	132	60	757.6	27.05
Oranges.....	{ E. P.	....	86.9	0.8	0.2	11.6	528	240	189.4	6.76
	{ A. P.	27.0	63.4	0.6	0.1	8.5	374	170	267.4	9.5
Peaches.....	{ E. P.	....	89.4	0.7	0.1	9.4	418	190	239.2	8.54
	{ A. P.	18.0	73.3	0.5	0.1	7.7	341	155	293.2	10.5
Pears	{ E. P.	....	84.4	0.6	0.5	14.1	649	295	154.1	5.5
	{ A. P.	10.0	76.0	0.5	0.4	12.7	572	260	174.8	6.2
Plums.....	{ E. P.	....	78.4	1.0	....	20.1	869	395	115.1	4.11
	{ A. P.	5.0	74.5	0.9	....	19.1	814	370	122.8	4.4
Prunes.....	{ E. P.	....	79.6	0.9	....	18.9	814	370	122.8	4.39
	{ A. P.	5.8	75.6	0.7	....	17.4	737	335	135.7	4.8
Strawberries...	{ E. P.	....	90.4	1.0	0.6	7.4	396	180	252.5	9.02
	{ A. P.	5.0	85.9	0.9	0.6	7.0	385	175	259.7	9.3

TABLE V.—PRESERVED FRUITS.

NAME.	Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Apples, sauce.... A. P.		61.1	0.2	0.8	37.2	1,606	730	62.3	2.22
Apricots A. P.		81.4	0.9	....	17.3	748	340	133.7	4.7
Blueberries A. P.		85.6	0.6	0.6	12.8	605	275	165.3	5.9
Cherries A. P.		77.2	1.1	0.1	21.1	913	415	109.5	3.9
Figs, stewed A. P.		56.5	1.2	0.3	40.9	1,727	785	57.9	2.07
Marmalade, { Orange } A. P.		14.5	0.6	0.1	84.5	3,487	1,585	28.7	1.02
Peaches A. P.		88.1	0.7	0.1	10.8	484	220	206.6	7.4
Pears A. P.		81.1	0.3	0.3	18.0	781	355	128.0	4.5
Pineapple..... A. P.		61.8	0.4	0.7	36.4	1,573	715	63.6	2.27
Prunes, sauce.... A. P.		76.6	0.5	0.1	22.3	946	430	105.7	3.7
Strawberries, { stewed } .. A. P.		74.8	0.7	....	24.0	1,012	460	98.8	3.5

TABLE VI.—GROCERIES.

NAME.	Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Barley, Pearl.... A. P.		11.5	8.5	1.1	77.8	3,630	1,650	27.6	1.0
Graham biscuit crackers } .A. P.		5.4	10.0	9.4	73.8	4,301	1,955	23.2	0.83
Biscuit meal, cracker meal } .A. P.		9.2	10.9	6.0	72.9	3,982	1,810	25.1	0.9
Saltines.....A. P.		5.6	10.6	12.7	68.5	4,411	2,005	22.7	0.81
Oyster biscuit....A. P.		4.8	11.3	10.5	70.5	4,323	1,965	23.1	0.83
Soda biscuit crackers }A. P.		5.9	9.8	9.1	73.1	4,235	1,925	23.6	0.84
White bread, } all analyses } .. A. P.		35.3	9.2	1.3	53.1	2,673	1,215	37.4	1.34
Graham bread....A. P.		35.7	8.9	1.8	52.1	2,662	1,210	37.6	1.34
Brown bread.....A. P.		43.6	5.4	1.8	47.1	2,310	1,050	43.3	1.54
Cheese, full cream }A. P.		34.2	25.9	33.7	2.4	4,200	1,950	23.3	0.83

TABLE VI.—GROCERIES.—(Continued.)

NAME.	Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Butter A. P.		11.0	1.0	85.0	....	7,981	3,605	12.6	0.45
Cake, all analyses, } .. A. P. except fruit }		19.9	6.3	9.0	63.3	3,685	1,675	27.1	0.97
Cocoa..... A. P.		4.6	21.6	28.9	37.7	5,104	2,320	19.6	0.7
Cornmeal, } A. P. granular }		12.5	9.2	1.9	75.4	3,641	1,655	27.5	0.98
Corn starch..... A. P.					90.0	3,685	1,675	27.1	0.97
Chestnuts, } E. P. dried..... } A. P.	 24.0	5.9 4.5	10.7 8.1	7.0 5.3	74.2 56.4	4,125 3,135	1,875 1,425	24.2 31.9	0.87 1.14
Chestnuts, } E. P. fresh..... } A. P.	 16.0	45.0 37.8	6.2 5.2	5.4 4.5	42.1 35.4	2,475 2,079	1,125 945	40.4 48.1	1.44 1.7
Cream, 25 per cent. butter fat } ... A. P.		63.0	6.0	25.0	6.0	2,805	1,275	35.7	1.27
Cream, 36 per cent. butter fat } ... A. P.		54.0	4.0	36.0	6.0	3,748	1,704	26.7	0.95
Cocoanut, } A. P. prepared }		3.5	6.3	57.4	....	6,875	3,125	14.5	0.52

TABLE VI.—GROCERIES.—(Continued.)

NAME.	Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Currants, dried....A. P.		17.2	2.4	1.7	74.2	3,289	1,495	30.4	1.1
Figs, dried.....A. P.		18.8	4.3	0.3	74.2	3,245	1,475	30.8	1.1
Flour, wheat, { all analyses } ...A. P.		11.4	10.6	1.1	76.3	3,663	1,665	27.3	0.97
Flour, buckwheat } .. A. P.		13.6	6.4	1.2	77.9	3,564	1,620	28.1	1.0
Ice cream..... A. P.		64.0	6.0	14.0	16.0	2,182	992	45.8	1.64
Gelatine .....A. P.		13.6	91.4	0.1	....	3,751	1,705	26.7	0.95
Honey .....A. P.		18.2	0.4	....	81.2	3,344	1,520	29.9	1.07
Lard, unrefined, { average } A. P.		4.8	2.2	94.0	....	8,822	4,010	11.3	0.41
Lard, refined.....A. P.				100.0	....	9,284 ^a	4,220	10.8	0.38
Lobster, { canned }A. P.		77.8	18.1	1.1	0.5	858	390	116.6	4.16

TABLE VI.—GROCERIES.—(Continued.)

NAME.	Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Molasses, cane....A. P.		25.1	2.4	....	69.3	2,838	1,290	35.2	1.26
Macaroni .....A. P.		10.3	13.4	0.9	74.1	3,663	1,665	27.3	0.98
Milk, whole.....A. P.		87.0	3.3	4.0	5.0	715	325	139.9	4.99
Mincemeat, commercial } ...A. P.		27.7	6.7	1.4	60.2	2,871	1,305	34.8	1.24
Mincemeat, home-made } ...A. P.		54.4	4.8	6.7	32.1	2,134	970	46.9	1.67
Olives, green... { E. P.		58.0	1.1	27.6	11.6	3,080	1,400	32.4	1.16
	A. P.	27.0	42.3	0.8	20.2	8.5	2,255	1,025	44.3	1.58
Oatmeal.....A. P.		7.3	16.1	7.2	67.5	4,092	1,860	24.4	0.87
Pickles, mixed....A. P.		93.8	1.1	0.4	4.0	242	110	413.2	14.4
Rice.....A. P.		12.3	8.0	0.3	79.0	3,586	1,630	27.9	0.99
Rolls, all analyses } ...A. P.		29.2	8.9	4.1	56.7	3,069	1,395	32.6	1.16

TABLE VI.—GROCERIES.—(Continued.)

NAME.	Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Starch, Corn.....A. P.		8.0	0.2	0.2	90.0	3,626	1,638	27.6	0.97
Sardines, { E. P.		52.3	23.0	19.7	....	2,772	1,260	36.1	1.3
canned..... { A. P.	5.0	53.6	23.7	12.1	....	2,090	950	47.8	1.71
Shredded wheat, { all analyses { A. P.		9.6	12.1	1.8	75.2	3,740	1,700	26.7	0.95
Soup, { Consommé }A. P.		96.0	2.5	....	0.4	121	55	826.4	29.51
Soup, { Mock Turtle } ..A. P.		89.8	5.2	0.9	2.8	407	185	245.7	8.8
Soup, Tomato.....A. P.		90.0	1.8	1.1	5.6	407	185	245.7	8.8
Sugar, { granulated }A. P.					100.0	4,092	1,860	24.4	0.87
Syrup, Maple.....A. P.					71.4	2,926	1,330	34.2	1.22
Vermicelli.....A. P.		11.0	10.9	2.0	72.0	3,575	1,625	28.0	1.0

TABLE VII.—FISH.

NAME.		Per Cent. Refuse.	Per Cent. Water.	Per Cent. Protein.	Per Cent. Fat.	Per Cent. Carbohydrate.	Calories per Kilo.	Calories per Pound.	Grams per 100 Calories.	Ounces per 100 Calories.
Salmon.....	{ E. P.	....	64.6	22.0	12.8	....	2,090	950	48	1.7
	{ A. P.	34.9	40.9	15.3	8.9	....	1,450	660	68	2.43
Bass,	{ E. P.	....	77.7	18.6	2.8	....	1,023	465	90	3.5
	{ A. P.	55.0	35.1	8.4	1.1		440	200	204	8.0
Lake Trout....	{ E. P.		70.8	17.8	10.3		1,683	765	59	2.1
	{ A. P.	48.5	36.6	9.1	5.1		847	385	118	4.2

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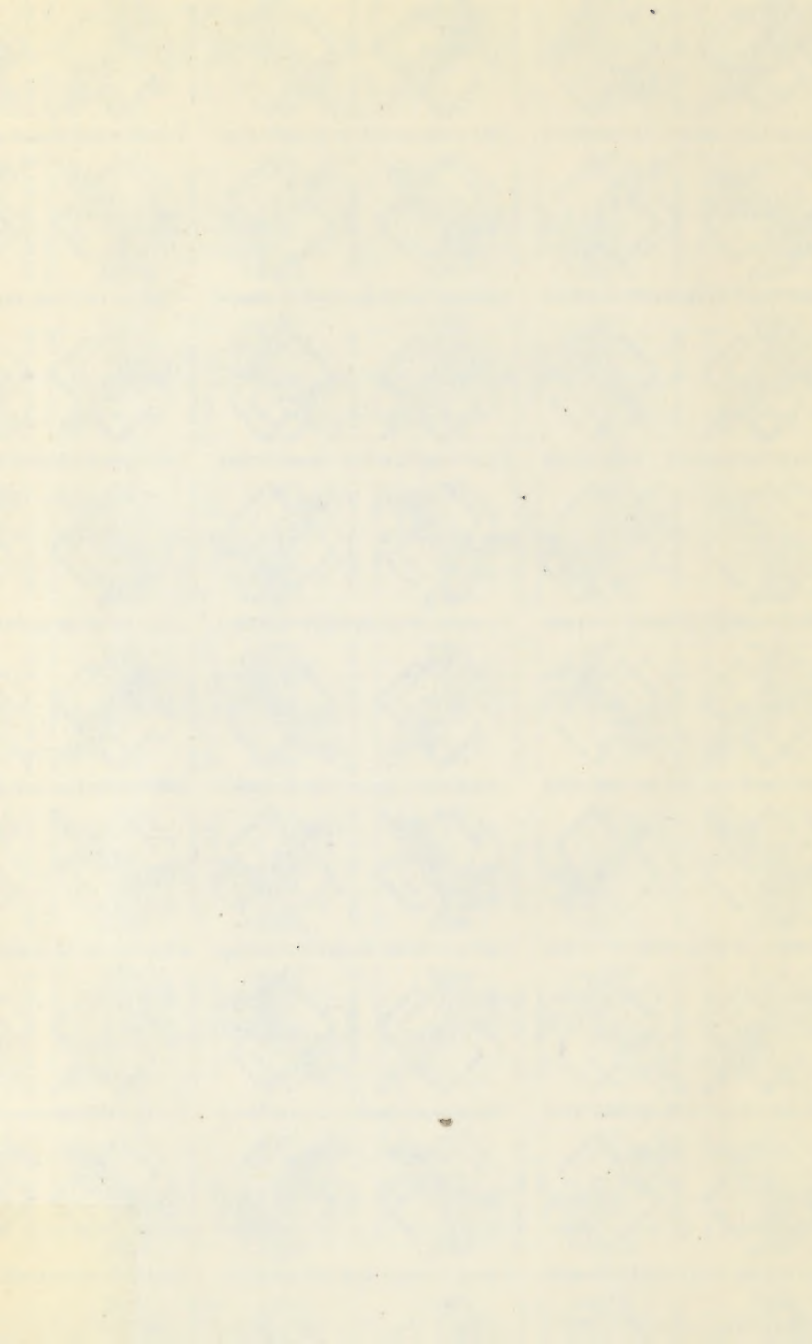
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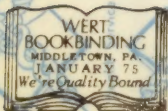
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